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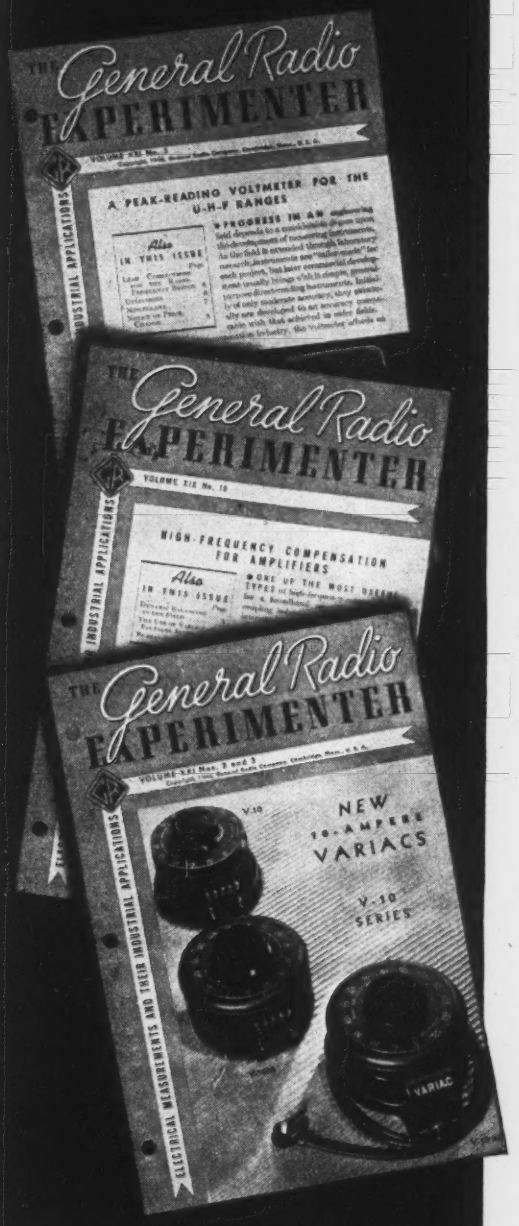
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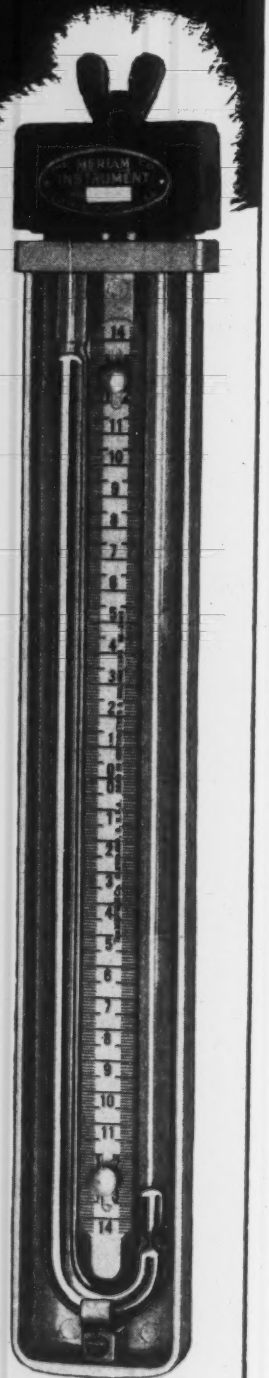

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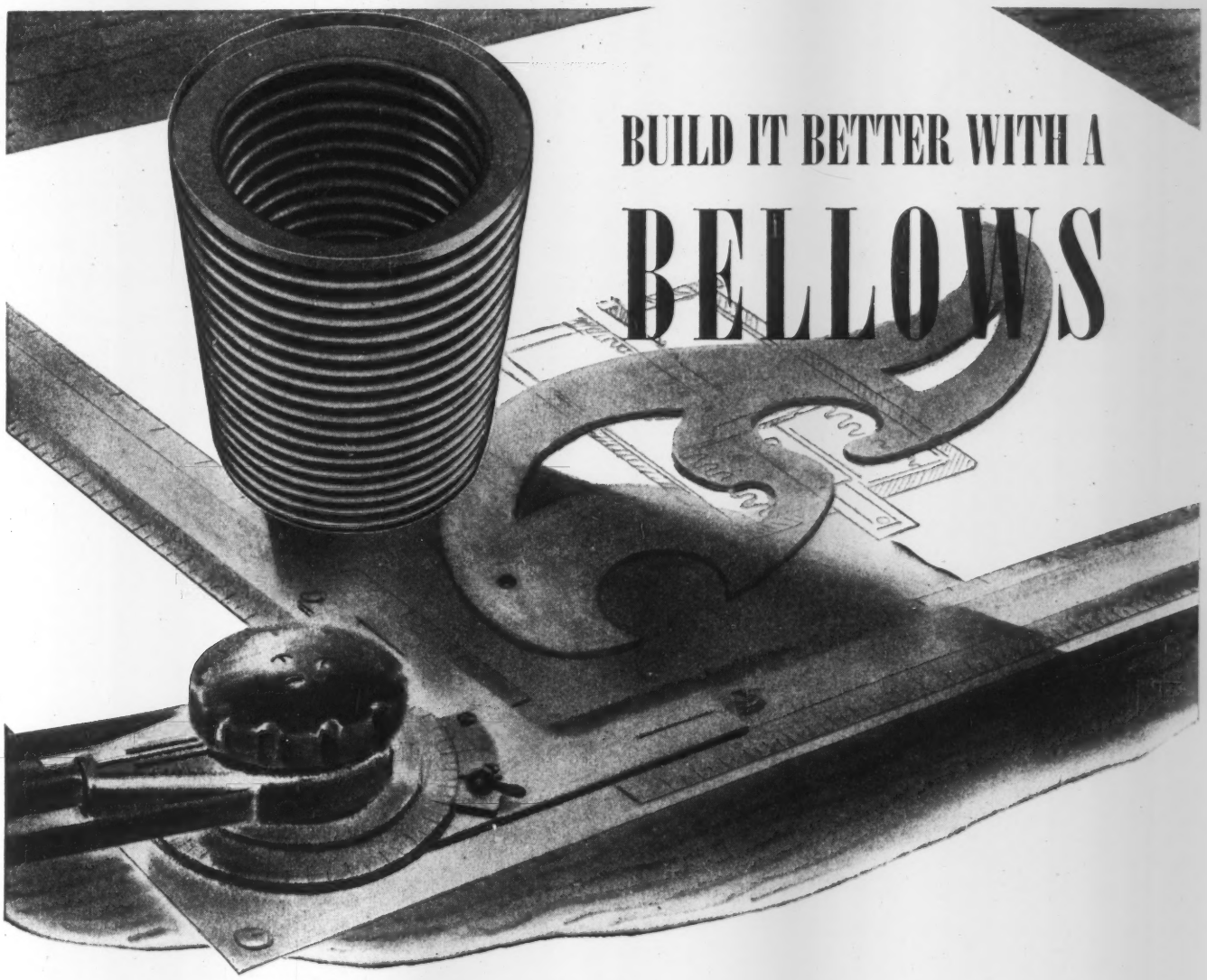

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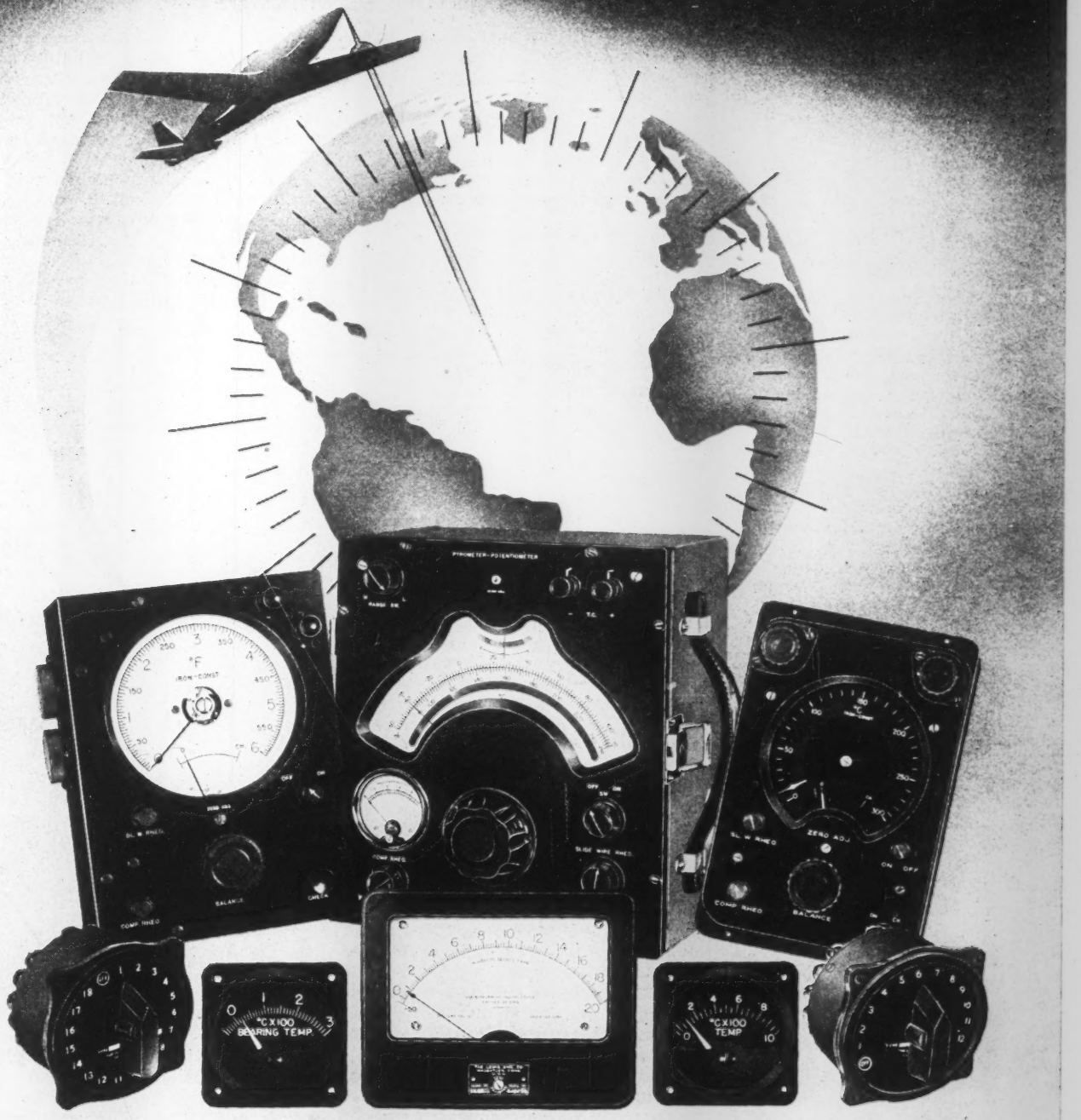

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INSTRUMENTS ON THE MARCH

Microwave Spectroscope

PITTSBURGH, Penna.—Electromagnetic waves from 1.2 to 1.6 cm. in length — radar wave-length — have found a new use in a microwave spectroscope developed for the analysis of chemical substances. Like the infrared spectroscope to which it is analogous, the microwave spectroscope can identify the more complicated molecules such as hydrocarbons without the laborious chemical processes involved in breaking them down and analyzing their various components.

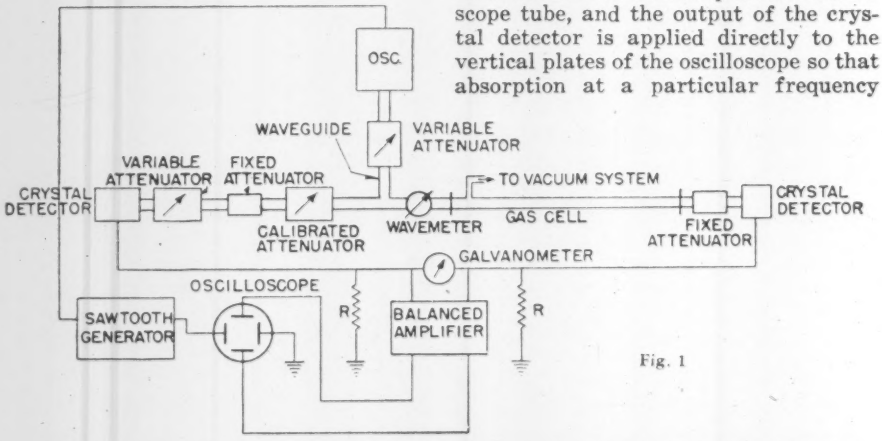

Fig. 1

Identification of whole molecules is accomplished by beaming microwaves through the vapor of the substance to be analyzed. Certain wave-lengths are absorbed by those molecules which they cause to rotate in resonance. For each substance there is a characteristic pattern of absorption lines which presents an easily-identifiable "fingerprint."

The basic elements of the microwave spectroscope as developed by Drs. William E. Good, Donald K. Coles and T. W. Dakin of the Westinghouse Research Laboratories are a radar type oscillator tube, a wave-guide, a crystal detector, an oscilloscope and a sweep generator. The diagram, Fig. 1, shows how these are set up.

Microwaves emitted by the oscillator tube are directed through a 15-foot-long rectangular wave-guide which contains the sample gas or vapor to be analyzed in a gas cell section sealed off with plastic tape. At the far end they are picked up by a sensitive crystal detector which passes the impulse received on to an oscilloscope. One end of this wave-guide is seen in Fig. 2 which shows Dr. Good operating the instrument. For clearer definition of the absorption lines the vapors in the gas cell are held to a pressure of about 0.1 mm. of mercury. The oscillator tubes used to obtain microwaves in wave-lengths varying from 1.2 cm. to 1.6 cm. are reflex klystrons tuned by changing the size of the resonant cavity. Several tubes are used to cover the band of frequencies required.

The frequency of the oscillator tube, or klystron, is swept in synchronism with the horizontal sweep of the oscilloscope tube, and the output of the crystal detector is applied directly to the vertical plates of the oscilloscope so that absorption at a particular frequency will be recorded as a vertical deflection of the oscilloscope trace.

Fig. 2

Ammonia has been found to have a pattern of thirty distinct absorption lines in this region which is its "fingerprint." Other compounds that have been tagged by this method are water vapor, acetone, cyanogen bromide, and carbonyl sulfide. The limitations of the microwave spectroscope are not yet known, but it promises to be a very valuable tool in the study of molecules and even of the atomic nuclei within the molecule.

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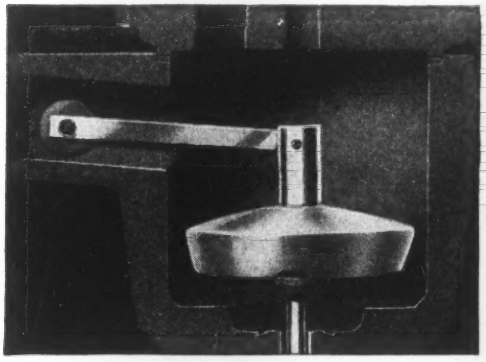

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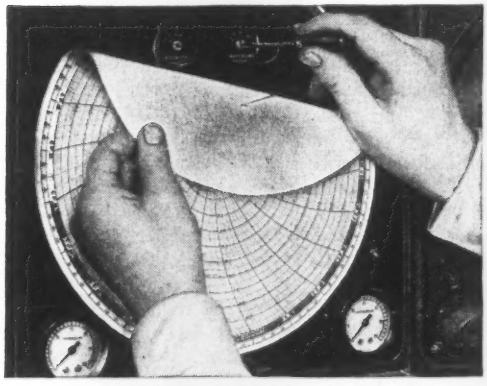

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New Use for Motion-study Stopwatches

CHICAGO.—Demonstrating that the technique of time and motion study can be transplanted from the factory to "my lady's boudoir," expert time study men carried out an experiment during the 10th annual Time and Motion Study Clinic held here. Using stopwatches, they analyzed the routine of applying theatrical make-up. The "subject" was Elizabeth Talbot-Martin, satirical impressionist oft seen in leading theaters and night clubs. Having put on her make-up in double-quick time under theatrical pressure for years, Miss Talbot-Martin figured that she knew all the angles, but the time study boys proved otherwise. By analyzing all motions, they showed her how to cut her make-up time from 17 minutes to 9¼ minutes.

New Approaches to Instrument Flight

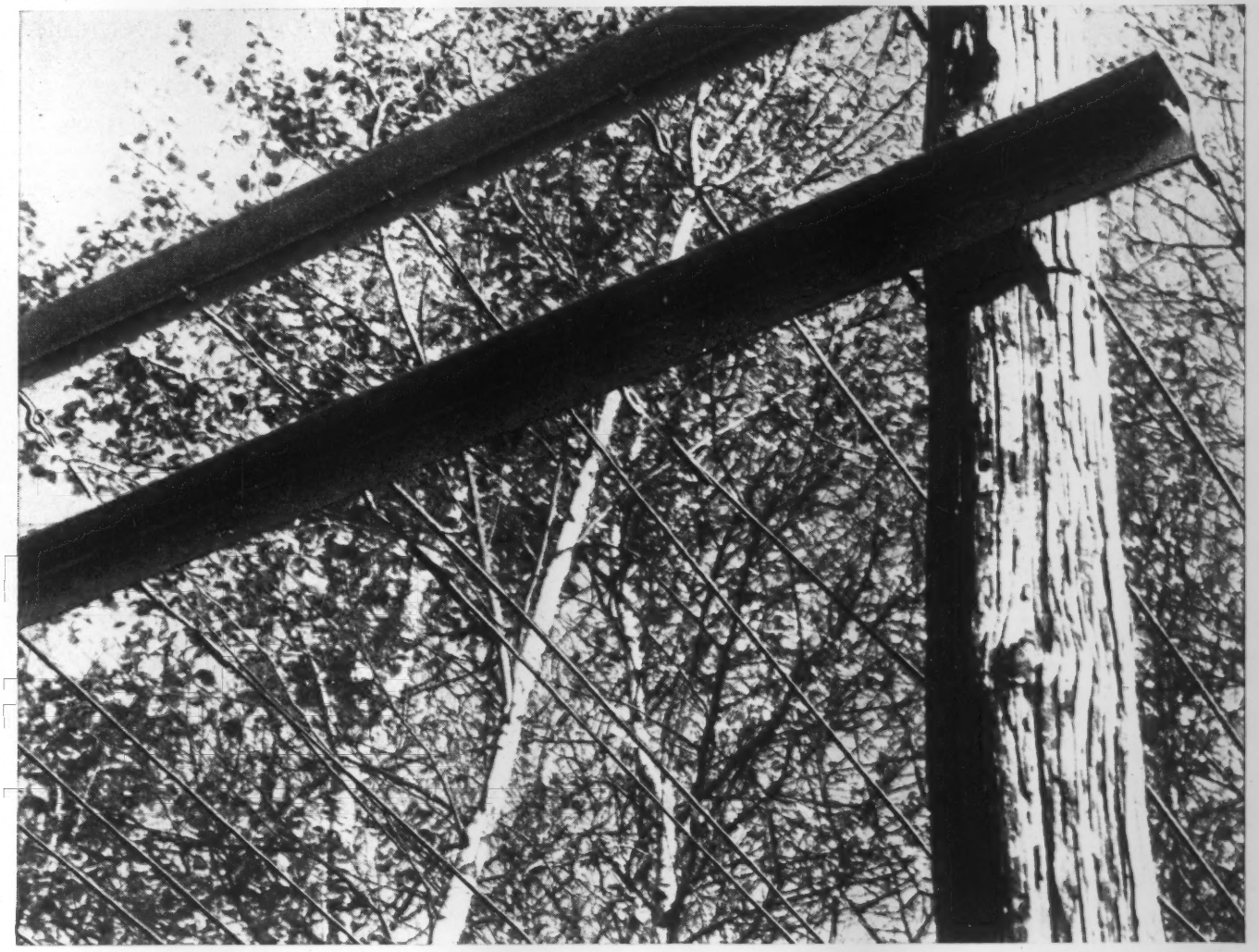
ELMHURST, N. Y. — Achievements of major significance in the aviation instrument field in 1947 are promised from the intensification of research and development made necessary by the advent of many new types of aircraft. The first full postwar year has been a fruitful one and the year ahead will bring similar progress in instrumentation that will open wider the new paths of human flight. Such is the prediction of Victor E. Carbonara, General Manager, Kollsman Instrument Division of Square D Company.

"In spite of the ups and downs of specific fields of aviation, aviation instrument manufacturers cover the whole aviation industry from personal planes to the biggest transport and including the jets, the helicopters and guided missiles. As an industry within an industry, we fare as the average of all aviation," continued Mr. Carbonara.

"Today's business forecasts must relate themselves to industry as it was before the war. On such a basis the aviation instrument companies show up well. While we displayed too much optimism on some specific developments in aviation, our overall predictions were more pessimistic than the fact. In spite of the cutbacks at the end of our inflated wartime production, our volume since V-J Day at Kollsman has exceeded both our prewar volume and our expectations for the first year of peace. The large volume of war surplus instruments available today has not diminished the need for standard instruments in all segments of the industry.

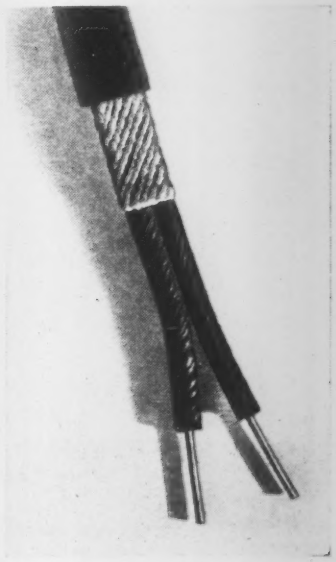
"Probably no period in the history of the aviation industry has been fraught with more problems than the last year, but there is no cause for pessimism. The art is not static. More than ever before there is youth and vigor about aviation. From dozens of research laboratories the aviation industry is racing on to new achievements.

"The armed forces continue to be the best supporter of developments because of the advent of jet and rocket aircraft and guided missiles. *The trend is toward more rather than less instrumentation.* More and more, man must depend on intricate mechanical, electrical and electronic instruments rather than on his own senses to orient himself to the conditions about him as modes of flight once the fantasy of a comic strip artist become reality. A great portion of our engineering staff is engaged in important military de-



Drop-wire undergoing abrasion tests in birch thicket "laboratory." Below, the new drop-wire, now being installed.

WE'RE GLAD THAT BIRCH TREES SWAY



The telephone wire which runs from the pole in the street to your house is your vital link with the Bell System. More than 17,000,000 such wires are in use.

The wire becomes coated with ice; it is ripped by gales, baked by sun, tugged at by small boys' kite strings. Yet Bell Laboratories research on every material that goes into a drop-wire—metals, rubbers, cottons, chemicals—keeps it strong, cheap, and ready to face all weathers.

Now a new drop-wire has been developed by the Laboratories which lasts even longer and will give even better service. It has met many tests, over 6 or 7 years, in the laboratory and in field experiments. It has been strung through birch thickets—rubbed, winters and summers, against trees, and blown to and fro by winds. In such tests its tough cover lasts twice as long as that of previous wires.

House by house, country-wide, the new wire is going into use. Wire is only one of millions of parts in the Bell System. All are constantly under study by Bell Telephone Laboratories, the largest industrial laboratory in the world, to improve your telephone service.

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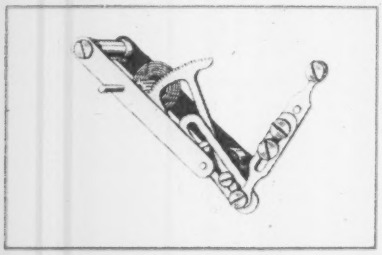
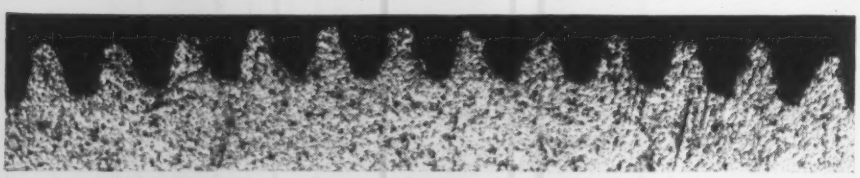
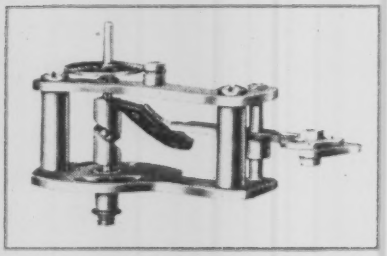


1 The movement of the ordinary pressure gage operates by means of a toothed segment and a spur gear as shown at right.



2 Magnified 12 times, the teeth of this new, unused sector are jagged – anything but uniform. Pinion teeth are cut the same way. Friction, wear and consequent inaccuracies are caused by these rough surfaces rubbing together.



3 Helicoid Gage movement has a polished, graphited Bakelite cam and a polished helicoid roller – instead of sector and pinion.

4 Cam of Helicoid movement magnified 12 times, shows smooth, polished surface. Helicoid roller surface is also highly polished. Longer wear and smoother operation result from these two polished surfaces in rolling, point contact.

Only Helicoid Gages have the Helicoid movement. That is one of several reasons why Helicoid is a better, longer-lasting pressure gage. Write for our complete catalog.

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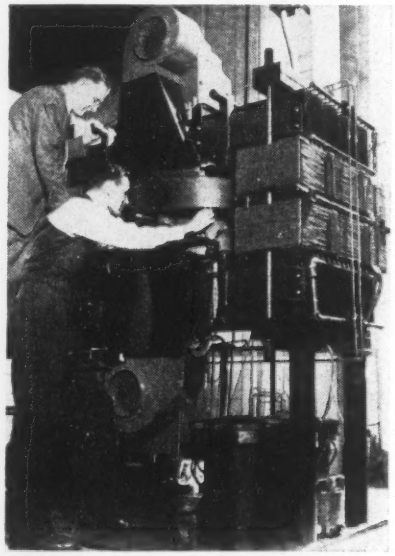
velopments of a confidential nature, which, when made public, will similarly stir the imagination of air-minded Americans.

"As these new approaches to instrument flight develop," concluded Mr. Carbonara, "every instrument takes on added importance and the need for more and better instruments to do more things increases."

America's First Synchrotron Yields 70,000,000-volt X-rays

PHILADELPHIA, Penna. — A beam of 70,000,000-volt x-rays has been produced in the General Electric Research Laboratory from a new and compact type of atom-smasher, the synchrotron. This was announced here by Dr. Herbert C. Pollock, G-E Research Laboratory scientist and leader of the group working on it, in a lecture before the Franklin Institute describing various types of atom-smashers in the G-E laboratory.

The success of this device, the first to operate in the Americas, built as part



of a project sponsored by the Office of Naval Research, indicates the possibility of producing radiations of much higher energies, for atomic study, with greater economy than with earlier equipment, according to Dr. Pollock.

The synchrotron as originally proposed was invented independently by V. I. Veksler, in Russia, and E. M. McMillan of the University of California where a 300,000,000-volt synchrotron is under construction. The new atom-smasher in its present form combines certain features of the cyclotron with those of the betatron, another type recently developed. While the cyclotron is used for accelerating protons, the synchrotron and betatron both are used for accelerating electrons.

The betatron has been developed principally at the University of Illinois and

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Magnetic Recording Tape with *full fidelity* performance

HYFLUX magnetic recording tape is a new "packaged energy" product of The Indiana Steel Products Company offering for the first time full, rich, high fidelity performance at moderate operational speeds. HYFLUX, the result of over a third of a century of experience in permanent magnet production augmented by independent research of the Battelle Memorial Research Institute, is a paper tape coated with fine high-energy magnetic particles with characteristics comparable to the well-known grades of Alnico. The simplicity of its design, its high fidelity performance, and the low cost materials used in fabrication provide HYFLUX tape with exceptional advantages for modern commercial recording.

Although The Indiana Steel Products Company will only produce HYFLUX Tape itself, the importance of developing a soundly engineered recorder for HYFLUX magnetic tape was recognized. The combined work of The Indiana Steel Products Company and the Physics Research Division of the Midwest Research Institute resulted in a single basic mechanism which incorporates outstanding new refinements in recording magnetics, electronics, mechanics, and acoustics. These engineering findings will be available to all recording machine manufacturers who are HYFLUX licensees. *Write today for additional information on the technical application of* HYFLUX *recording tape.*

* Reg. U. S. Pat. Off.

HYFLUX Magnetic Recording Tape Brings These New Advantages to the Field of Sound Recording

- High Fidelity Performance
- Low Operating Cost
- Compact . . . ½ hour recording on a single 8 MM reel.
- Flexible and Durable in Use
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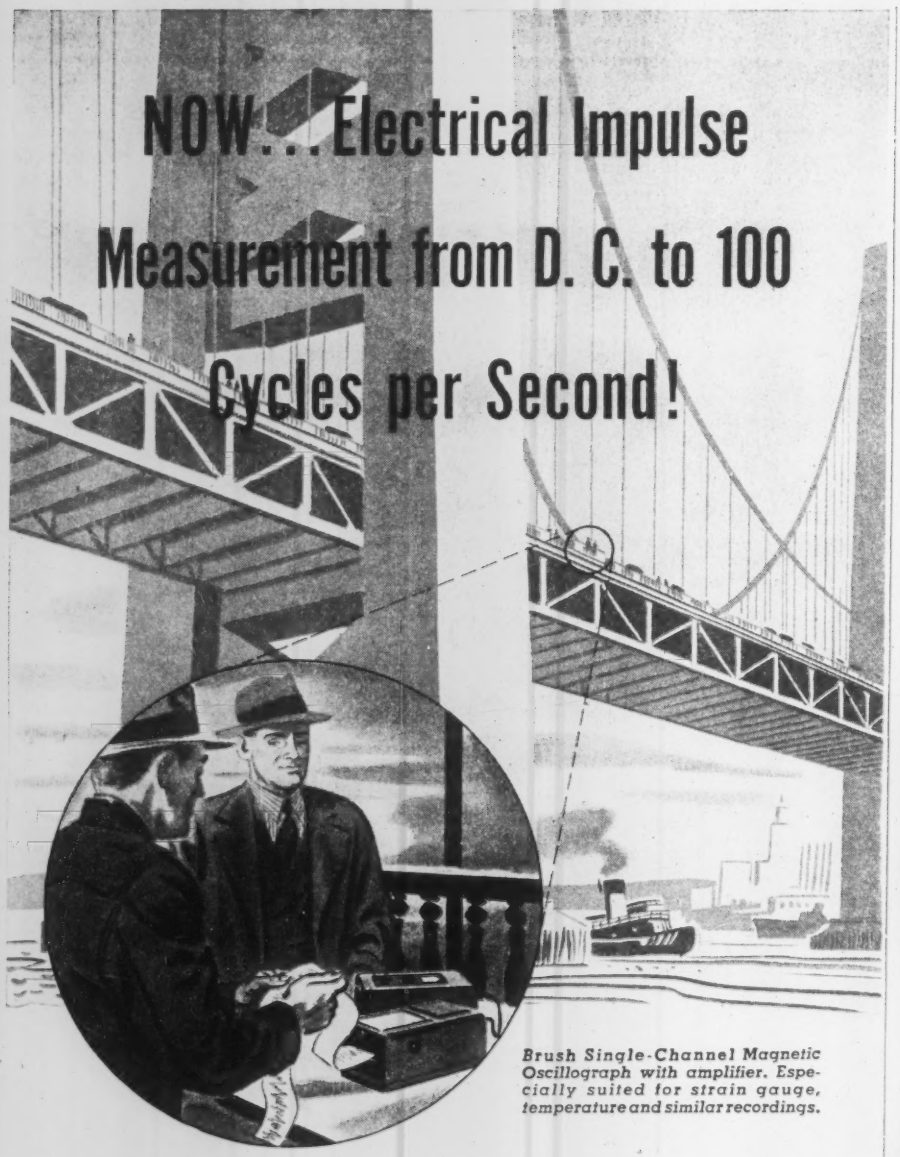
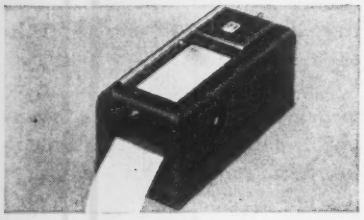


Brush Single-Channel Magnetic Oscillograph with amplifier. Especially suited for strain gauge, temperature and similar recordings.

Brush Oscillographs make direct-inking recordings

Brush Magnetic Oscillographs may be used for making detailed recordings of electrical impulses for an almost limitless number of applications. The Magnetic Pen Motor is capable of recording a D.C. signal. Used with the BL-905 amplifier, the frequency range is from .2 to 100 cycles per second. Recordings are direct, instantaneous, ink-on-paper graphs. Can be used for recording strains, pressures, vibrations, temperatures, light intensity and countless other phenomena.



Brush Double-Channel Magnetic Oscillographs for use where two simultaneous recordings are desired —as in synchronizing problems.

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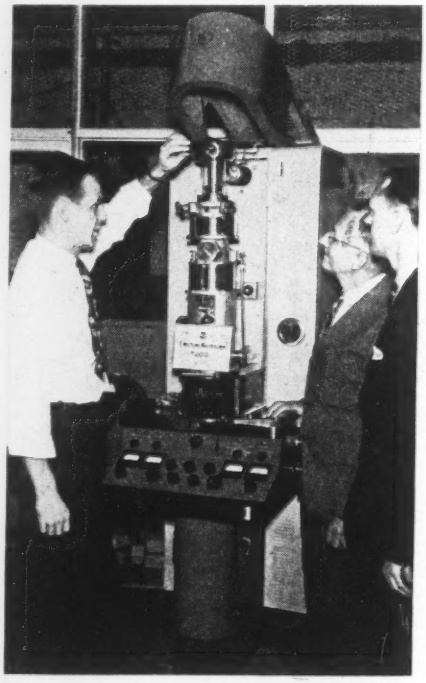
at the G-E laboratory, where one weighing 135 tons and emitting 100,000,000-volt x-rays is now operating. [This one was described in *Instruments*, Dec. 1942, pages 538-539; Nov. 1946, page 658.—EDITOR.]

Though the 70,000,000-volt radiation from the new synchrotron has more than two-thirds the energy of that from the betatron, the machine is smaller, weighing only about eight tons. Thus, said Dr. Pollock, it offers fascinating possibilities for going to much higher voltages with less weight of iron. The 200,000,000-volt cyclotron recently placed in operation at the University of California, he reminded his audience, weighs about 4000 tons.

The new instrument combines both betatron and synchrotron operation, and was invented jointly by Dr. Pollock and his associate, W. F. Westendorp. At the beginning of each cycle of operation, which is repeated 60 times a second, the acceleration of electrons starts off as in a betatron and is continued as



Northwestern University Receives 200th RCA Electron Microscope

Completion of the 200th RCA electron microscope was the occasion for a ceremony in the Camden, N. J., plant of the RCA Victor Division. Arnold Wilson (left), is shown applying the finishing touches to the instrument as Dr. Paul E. Klopsteg (center), Director of Research of Northwestern University, and T. A. Smith, of the RCA Engineering Products Dep't, look on. The new supersensitive electronic "eye," which makes possible the magnification of otherwise invisible particles up to 100,000 times, was turned over by Mr. Smith to Dr. Klopsteg. It will be shipped to Evanston, Illinois, for use in Northwestern's Technological Institute.

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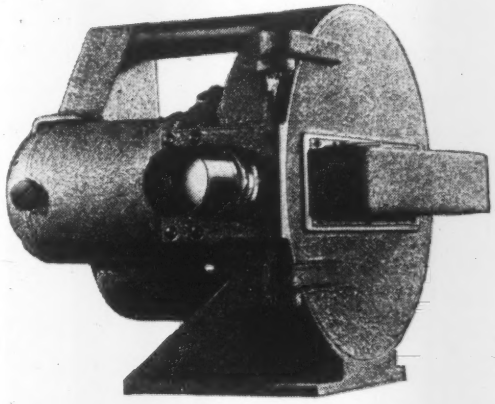

Western Electric FASTAX CAMERA

- 16 mm takes motion pictures up to 4000 per sec.; 8 mm up to 8000
- Discloses innermost secrets of fast moving parts
- Solves many industrial problems

Designed by Bell Telephone Laboratories, the new Fastax is the world's *fastest portable motion picture camera.*

Capable of photographing the action of high speed machinery—indoors or outdoors—at speeds up to 8000 pictures per second, the Fastax is extremely helpful in research and design engineering of aircraft, automobiles, machine tools, textile machinery—in fact any product having rapidly moving parts.

When Fastax pictures are projected on the screen at the rate of 16 per second, the resultant s-l-o-w motion, or "time magnification," discloses the innermost secrets of fast-moving parts—shows up weaknesses—leads to better design.

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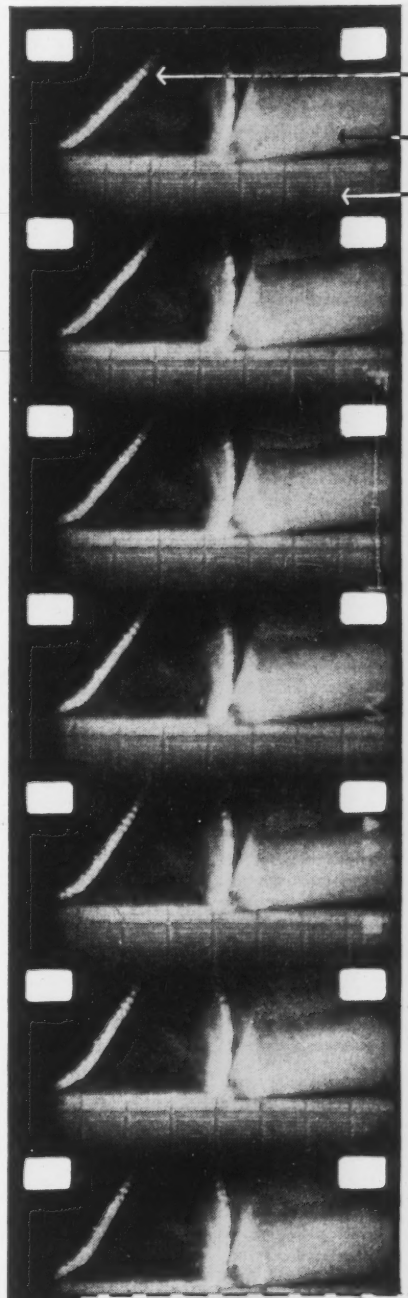

SEE how it works for the machine tool industry

Here the Fastax Camera "stops" the action of the cutting head of a 32" shaper, going at 65 surface feet per minute, as it bites into a piece of 18-8 stainless steel. It is making a .015" cut. Note the shaving traveling ahead of the cutter.

These unretouched enlargements are from a 16 mm Kodachrome film taken at a speed of 4000 frames per second. Fastax motion pictures taken with the cutter at different angles will show clearly the "rake angle" best for the job.

Pictures taken with this camera are ideal for studies of all types of machine tool operations—cutting, milling, grinding, drilling, shaping, etc. If you are in the machine tool industry, it's a good bet you can use a Fastax camera to advantage.

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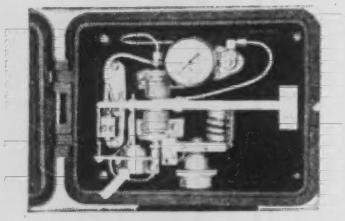

PHOTO, COURTESY THE SWARTWOUT CO.

The Thermo Master Control and other control instruments made by The Swartwout Company of Cleveland have been redesigned and made even more sensitive through use of a damping device filled with one of the Dow Corning Silicone fluids (arrow). Previously no damping device was used because conventional organic fluids are subject to such wide changes in viscosity with temperature that they limit rather than increase the sensitivity of these carefully engineered instruments.

With the introduction by Dow Corning of Silicone Fluids, unique among liquids for their flat viscosity-temperature slopes, low volatility, and thermal stability, the long standing problem of effective damping over a wide temperature range was solved.

The Thermo Master Control is widely used for regulating temperature in steam desuperheating involving temperatures ranging from 50° to 950°F. Ambient temperatures may vary from −40°F. to 150°F. Over such a wide temperature span, only silicone fluids remain sufficiently constant in viscosity to damp minor oscillations of the metallic control without lessening the sensitivity of such precision instruments.

More information about DC Silicone Fluids, available in several types for a wide variety of applications, is contained in catalog No. P 1-3.

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in a synchrotron. The electrons are injected from a hot filament and are speeded as the magnetic field builds up. When they have acquired energies of about 2,000,000 volts, they are moving at 97% of the speed of light.

Part of the doughnut, which has an outside diameter of 27", is made of metal, double-walled and with a gap on the inside. This is connected with an electrical oscillator, essentially a radio transmitter operating on a frequency of 163 Mc. or a wave-length of a little less than two meters. After the electrons have reached 2,000,000-volt energies, and are moving practically at constant speed (nearly that of light) the oscillator is automatically turned on. In the oscillating electric field, the electrons quickly get into step and come around in groups, receiving an increase in energy each time they go past.

Dr. Pollock explained that this takes care of another limitation to the betatron. When electrons are moving at energies of many hundreds of millions of volts, they actually radiate away much of their energy, just as do the electrons moving back and forth in a radio antenna system. With the synchrotron, however, there is automatic compensation: if an electron loses energy, its orbit contracts, and the next time it returns to the gap a little sooner. This causes it to get more than its normal quota of energy.

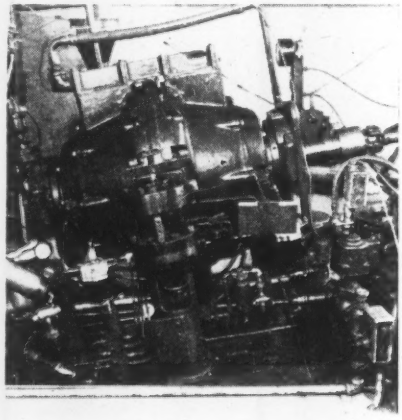
After the electrons have reached their full velocity, said the speaker, the oscillator is turned off. All the electron orbits contract.

Buick Engine-testing Dynamometers

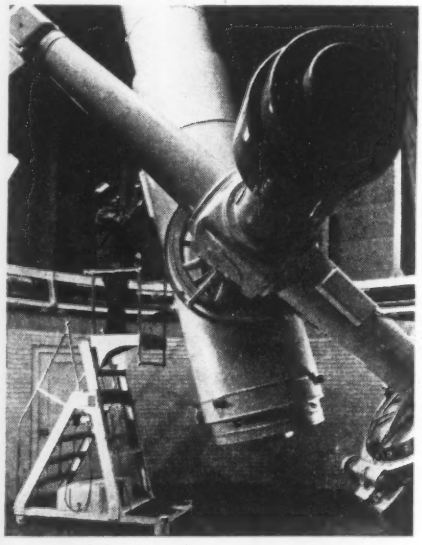
FLINT, Mich. — Buick Division of General Motors, building a new set-up for engine testing, is measuring force and horsepower with new methods, using the Pittsburgh-developed Hagan "Thrustorq" as the measuring instrument, and results over the past two years have proved so satisfactory to the engineers at Buick that similar devices are to be employed on many different testing jobs.

In developing the new testing procedure, it was felt desirable to test Buick engines at approximately the same angle at which they will operate in the finished Buick automobile. As a result, the present dynamometer installation is tilted 10° from the horizontal. This permits operation of the engine at angles up to 20° without a serious angular deflection in the universal joint which transmits engine power to the dynamometer. If desired, the dynamometer could be mounted at any angle from horizontal to vertical.

Two other major tests are now being planned, each to be equipped with "Thrustorqs," according to Buick engineers. One will be in connection with a Gleason axle-testing machine. In this test two axles will be hooked together, force being applied in opposite directions. The second major test installation will be a new chassis dynamometer testing machine. In using this machine the car is anchored so that it cannot move; the wheels, however, turn at road speed. "By these various new tests," say Buick



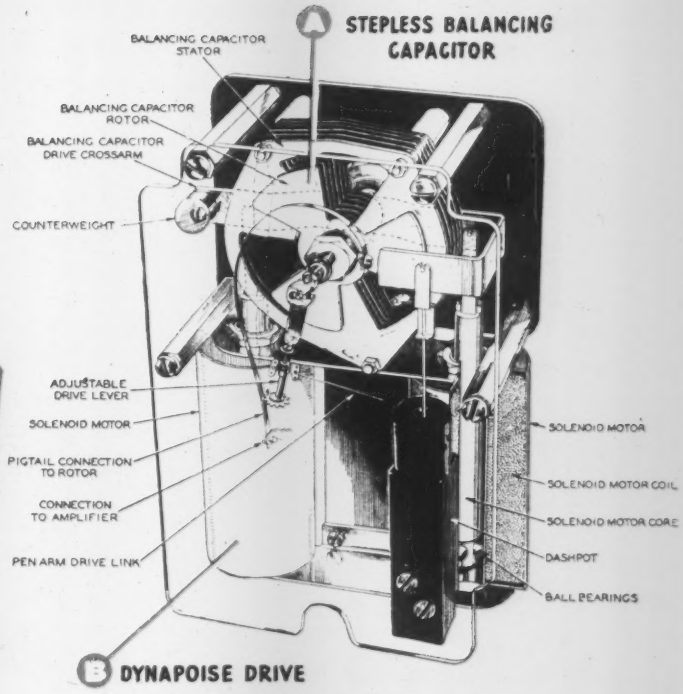
engineers, "we hope to develop better carburetion, better engine design, better valves, better axles and in general better performance. While present automobile production is not high, our research men are already working on tomorrow's automobiles, and they should be better and tougher than anything seen so far because we do have better metals and far more accurate testing."



No More Back-breaking Step-ladders for Telescope Users

Dr. J. J. Nassau, professor of astronomy, Case School of Applied Science, and director of the Warner & Swasey Observatory in East Cleveland, O., working on 24-36-inch telescope from platform of new lightweight, power-operated observation-platform elevating unit built by the Elwell-Parker Electric Co. of Cleveland. An adjunct to a great instrument, the new lift-platform is itself, "instrumentized" with modern controls. Developed for pure science, this new device has industrial applications in materials handling, etc.

Only Dynalog Instruments offer STEPLESS continuous balancing!



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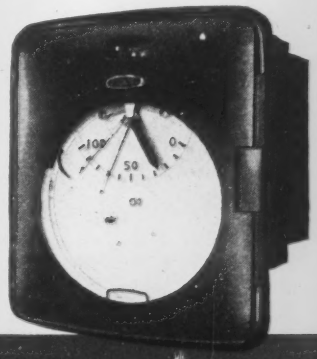

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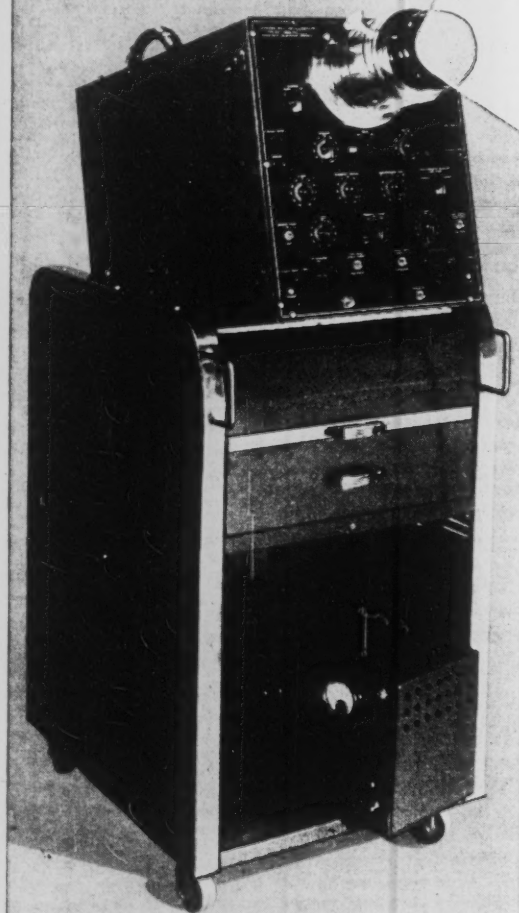

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Modified from the Type 247, this new Du Mont Type 247-A is such a startling success that phenomena hitherto totally invisible can now be *easily* seen. Such modification extends the range of the instrument tremendously in the field of transient studies or high-speed photographic applications.

The modification utilizes the new Type 5RP Cathode-Ray Tube operable at voltages up to 30 KV, producing sufficient brilliance for direct projection, if required.

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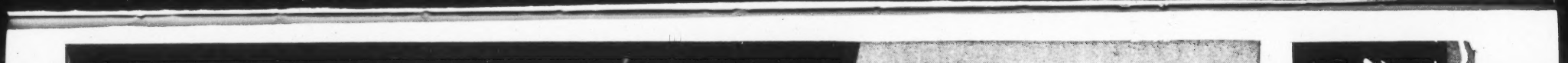

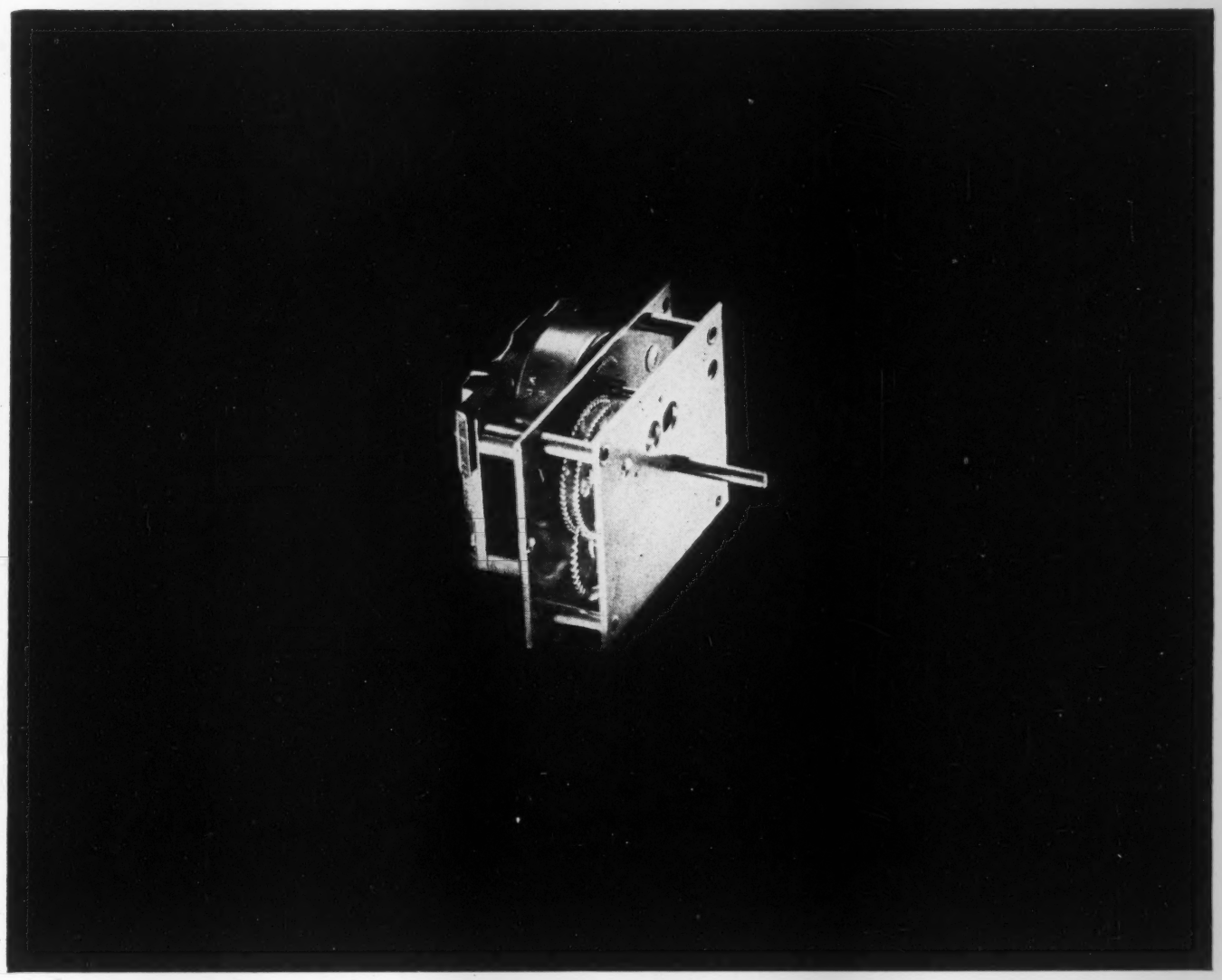

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HERE'S a sturdy, compact synchronous electric movement that assures complete dependability for industrial controls. The Telechron IM-8 is designed for boiler heat controls, stoker controls, time switches and similar installations.

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These Underwriters Laboratories approved motors give any industrial control device the advantages of famous Telechron accuracy and low maintenance cost. They are self-starting, quiet in operation and are not affected by normal changes in voltage or temperature. The exclusive sealed-in lubrication system assures long, trouble-free life. Telechron motors have been used successfully in clocks and timing devices for 25 years—and more. Experienced Telechron *application engineers* will be glad to study your needs and make recommendations. There's no obligation. Just address Motor Advisory Service, Dept. B.

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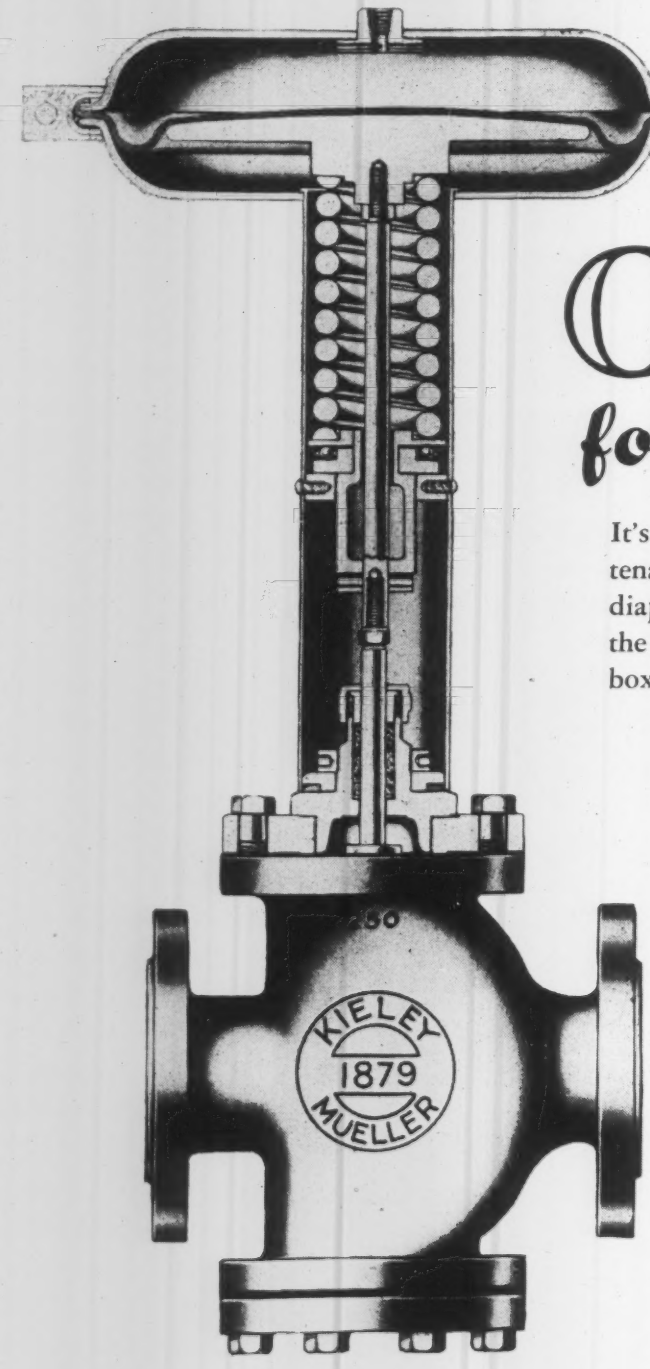

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- Pressed steel Diaphragm Casing . . . lighter . . . tougher.
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Used with air operated instruments or auxiliary pilot units, the K & M Kontrol Motor controls pressure or flow of steam, liquid, gases or air — efficiently and sensitively. Send us your control problems — we'll show you how Kontrol Motor will solve them. Write for new Kontrol Motor bulletin.

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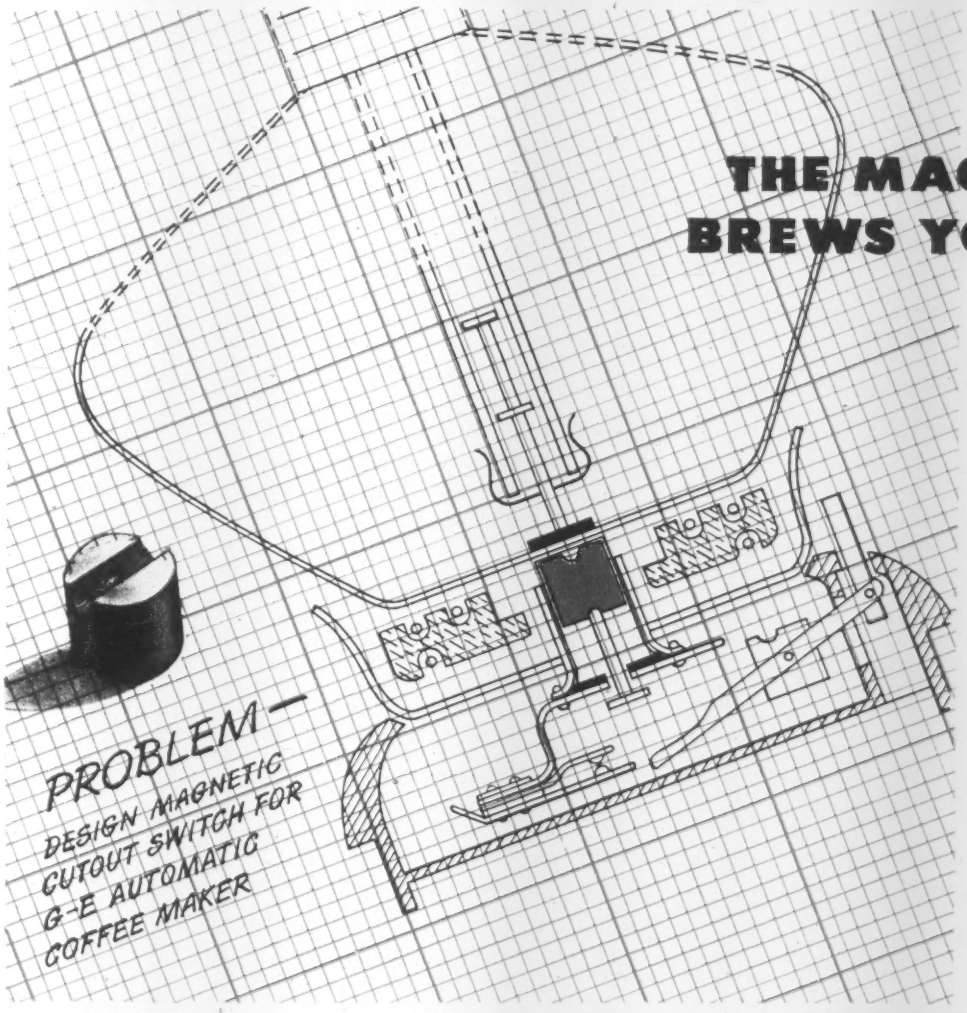
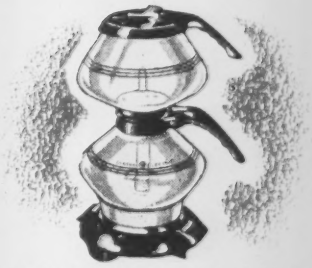


THE MAGNET THAT BREWS YOUR COFFEE



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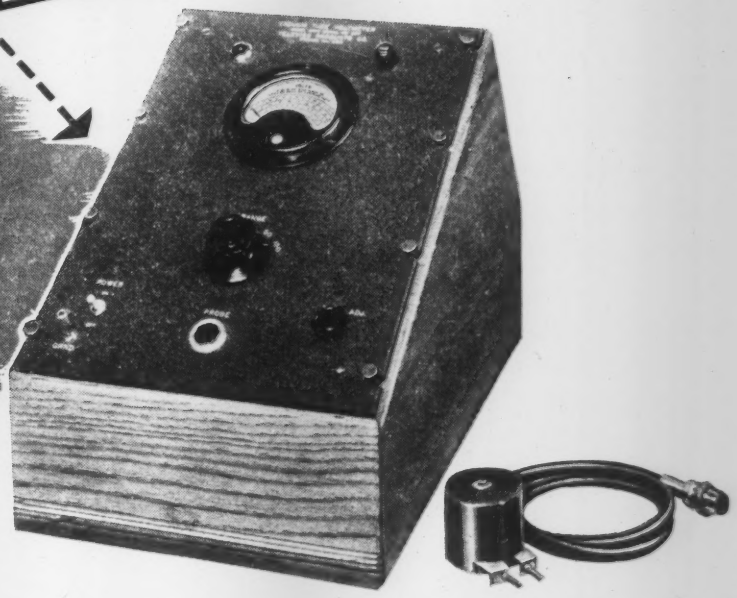

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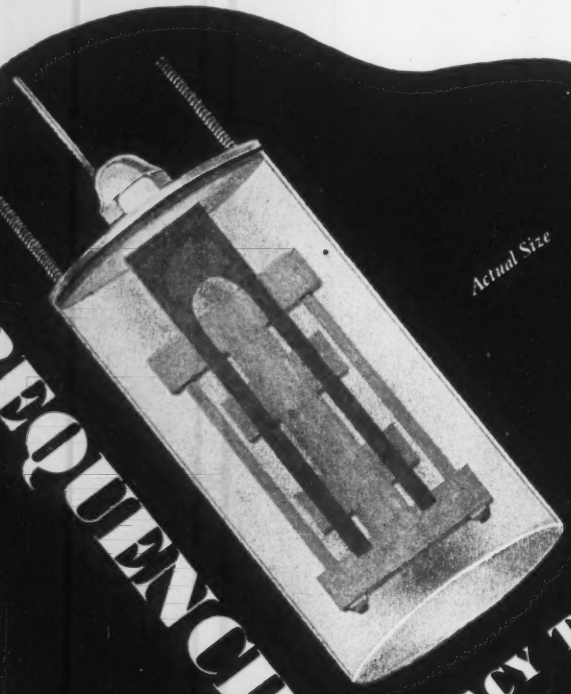

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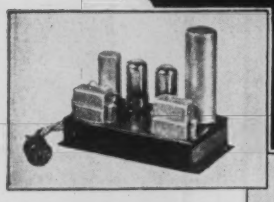

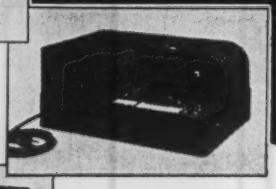

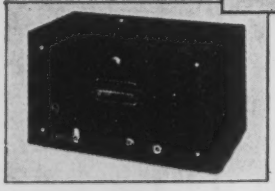

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P-8

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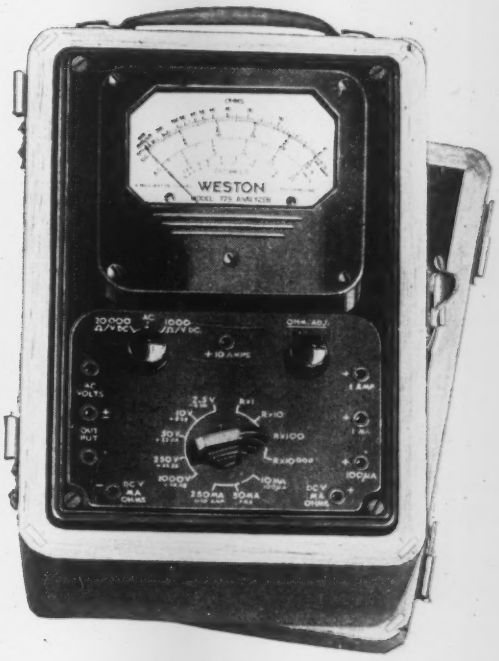

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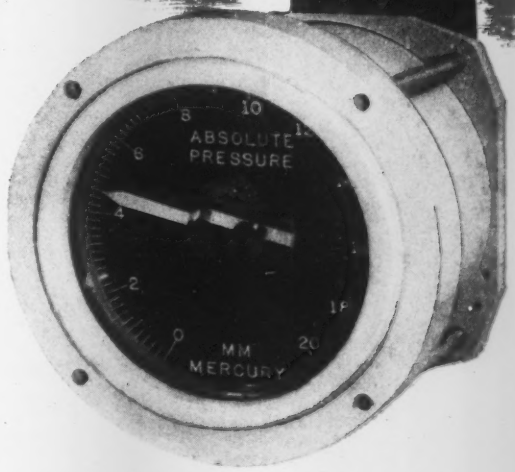

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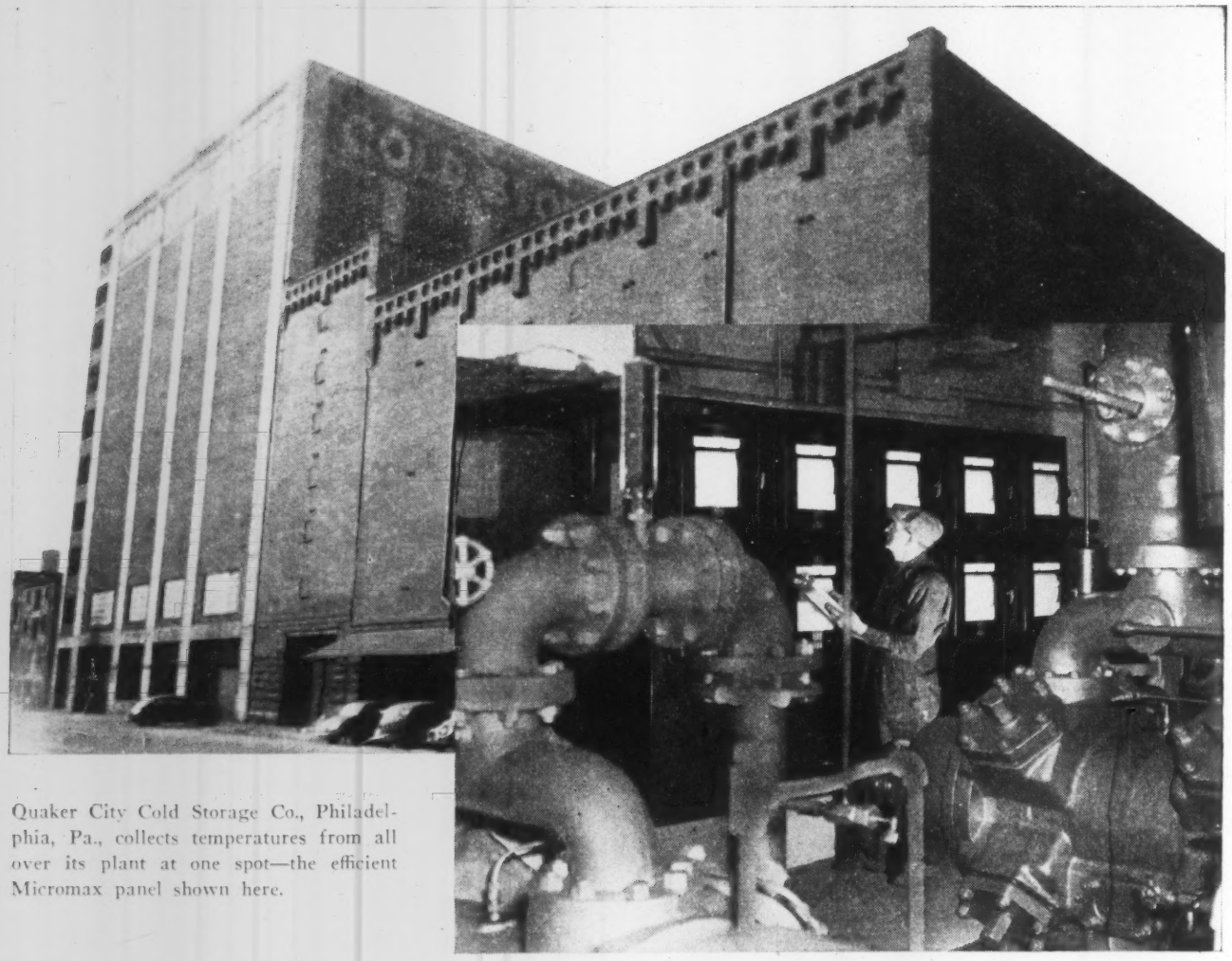
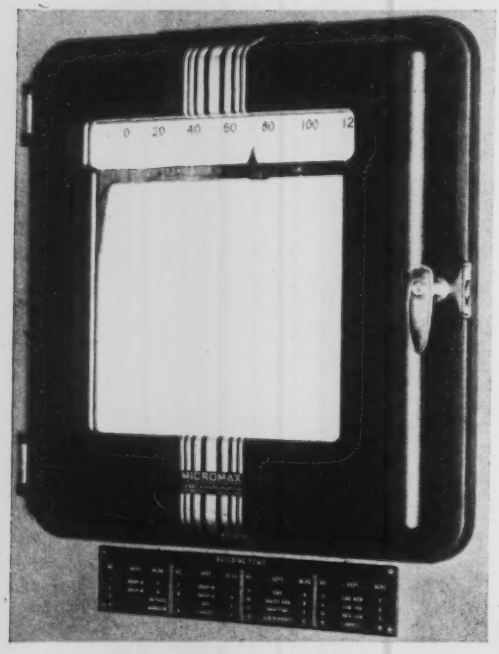


Quaker City Cold Storage Co., Philadelphia, Pa., collects temperatures from all over its plant at one spot—the efficient Micromax panel shown here.

Big Buildings Save Big Sums with Micromax Temperature Recorders



Typical Micromax Recorder, mounted on panel, for providing accurate information about building temperatures.

The daily miles of walking required to read temperatures in the big Quaker City building shrank to a few yards when Micromax instruments centralized the job of temperature recording. And this is just one reason why Micromax saves time, effort and money for efficiency-minded building managers. Along with the reduction in labor, temperature changes are reported more quickly and therefore corrected more promptly. This gives not only a substantial saving in power, but also a smoother temperature curve for each building area.

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Jri Ad N-33-220(1)

Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Vilification Can't Abate Smoke; Instrumentation Can!

ONE of the standard features of a publicity crusade seems to be the "heroes-and-villians angle." It is being played up here in Pittsburgh, in connection with the revival of the war-interrupted smoke-abatement crusade. One crusading editor picks out as his biggest villains the three biggest interests: the big railroads, the big iron and steel plants and the big power plants . . . and of course he's a triple hero to many of his readers, who imagine that railroads, steel plants and power plants make more money by producing more smoke than they should.

This is an illogical consequence of the outworn local saying that smoke means prosperity. It used to be true, a quarter-century ago, that *absence* of smoke in a normally-smoky industrial town was a sign of hard times. But today everybody with a high-school education knows the fallaciousness of this proposition and of its converse.

No, we don't go for that "heroes-and-villains" method of inflaming the populace against big business or against any segment of the American body politic. We believe that there are good and bad *individuals* in all segments. And we always prefer to heap praise on heroes without selecting (or inventing) villains. In connection with smoke prevention, our hero-of-the-month is M. W. Crew of the Perfex Corporation in Milwaukee. We have learned that last month Mr. Crew wrote and donated to the Smoke Prevention Association of America a 16-page 8½"×11" booklet entitled "Smoke—Its Cause, Cost and Prevention." This handy guide is full of *easy-to-read* information (without a single graph!) and is absolutely free from advertising.

An admirable feature of this guide is that the simplicity of its English is on a par with the simplicity of the methods it recommends. For example, the section on "Hand Coal Firing" can be understood by many a housewife and by every operator of a commercial establishment such as a laundry. This section concludes as follows:

Simple instruments are invaluable as a guide to hand-firing. Dependable and reasonably priced instruments and controls are available. If a combination of (1) automatic draft control, (2) over-draft gage, and (3) flue gas temperature indicator is used by the operator of a hand-fired installation, he will have the necessary tools to effect savings, smoke reduction, and operational improvement, resulting in savings far exceeding the cost of these moderately-priced instruments.

Other sections deal with stoker firing and oil firing, each subdivided into various topics. These are preceded by a first section on "Cause of Smoke" and a second one on "Cost of Smoke" which neither pull punches nor vilify any groups of citizens. The second section concludes as follows:

Legal Aspect.—Numerous forward-looking cities have already enacted legislation, and dozens more are considering legislation which outlaws smoke and fly ash. Such legislation, when intelligently written and fairly and fearlessly enforced, does not work a hardship on any individual, group or industry. This is true by virtue of the fact that fuel economies, effected over a short period of time by the elimination of smoke, will in almost all cases exceed the cost of smoke eliminating equipment. Thus anti-smoke legislation becomes one of the few restrictive measures from which everyone benefits.

Mr. Crew asked us not to praise him, but he deserves praise. He asked us to give credit to the SPAA committee, and this we do cheerfully. Here are the members of the Combustion Equipment Standardization Committee of the Smoke Prevention Association of America:

M. W. Crew (Chairman), Manager, Commercial Control Division, Perfex Corp., Milwaukee, Wis.;

Dr. H. J. Rose, Bituminous Coal Research, Oliver Building, Pittsburgh 22, Penna.;

Dr. Raymond C. Johnson, Vice Pres. Anthracite Industries, Inc., Primos, Delaware County, Penna.;

E. D. Benton, Locomotive Research, Battelle Memorial Institute, Columbus, Ohio;

Lloyd Connell, Technical Director, Stoker Manufacturers Ass'n, 307 N. Michigan Ave., Chicago 1, Illinois;

C. Bronson, Kewanee Boiler Co., Kewanee, Illinois, (Chairman, Technical Committee Steel Boiler Institute);

G. T. Kaufman, Technical Secretary, Oil-Heat Institute of America, 30 Rockefeller Plaza, New York 20, N. Y.;

Otto de Lorenzi, Director of Educ., Combustion Engineering Co., Inc., 200 Madison Ave., New York 16, N. Y.;

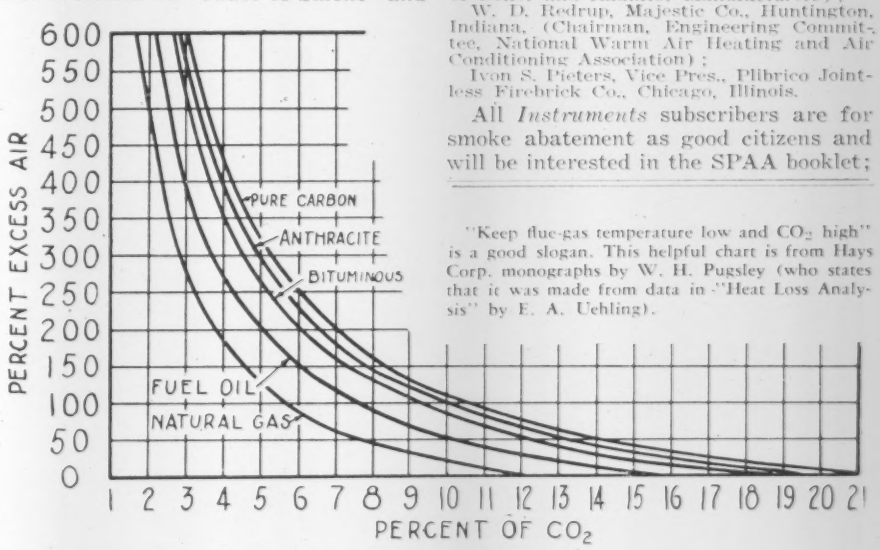
Wm. H. Pugsley, Chief Engineer, Hays Corporation, Michigan City, Indiana;

M. W. McRae, Crane Company, Chicago, (Chairman, Technical Committee Institute of Boiler and Radiator Manufacturers);

W. D. Redrup, Majestic Co., Huntington, Indiana, (Chairman, Engineering Committee, National Warm Air Heating and Air Conditioning Association);

Ivon S. Pieters, Vice Pres., Plibrico Jointless Firebrick Co., Chicago, Illinois.

All *Instruments* subscribers are for smoke abatement as good citizens and will be interested in the SPAA booklet;



"Keep flue-gas temperature low and CO_2 high" is a good slogan. This helpful chart is from Hays Corp. monographs by W. H. Pugsley (who states that it was made from data in "Heat Loss Analysis" by E. A. Uehling).

many *Instruments* subscribers are interested in the fuel-saving and other economic aspects; those subscribers in plants with steam boilers of 200 hp. or more are particularly interested in "full-automatic" combustion control. Mention should here be made, therefore, of *Instruments*' big Special Issue on Automatic Combustion Control (Oct. 1938) which contained comprehensive technical descriptions of all American makes of fully-automatic combustion control systems, each adequately illustrated, each written by an engineer associated with its development. This Special Issue is out of print but may be consulted in any company library or public technical library where *Instruments* is on file. It is worth consulting —and we say so only after perusing it to make sure that it is still up to date in all essentials. Mention may also be made of the fact that the fuel-saving aspects were dealt with in our October 1944 issue, page 593, in particular connection with the Bureau of Mines' National Fuel Efficiency Program and the (non-government) National Fuel Efficiency Council. —MFB.

Specialized Instrumentation for Flight Testing*

By JOSEPH P. PAINE, The Glenn L. Martin Company, Baltimore, Md.

STRINGENT performance and safety requirements for an airplane of today necessitate a high degree of instrumentation on the test airplane to properly secure the required data with accuracy and speed. Such instrumentation must be capable of operation under severe conditions of temperature, vibration, acceleration, and altitude, yet must be sufficiently sensitive to measure the small magnitudes often encountered. Frequently all data must be recorded automatically by special devices to obtain the maximum information with the minimum loss of time.[1]

Many measurements are made by means of conventional systems with minor modification to facilitate flight testing. For example, the automatic multiple-point null-balance potentiometer is widely used for the measurement of temperatures on test airplanes. Minor changes are often incorporated to secure automatic standardization and numbering, simpler operation, and greater ease of installation. Similarly, for slowly-varying position indication, any of several self-synchronous remote-positioning systems is commonly used.

The limited scope of this article prevents detailed discussion of every method for obtaining test information. No attempt has been made to outline or consider instrumentation felt to be well standardized. The article is devoted to brief discussions of typical applications of instrumentation for the procurement of special flight information. Many of these instruments and methods have been developed by The Martin Company during the past few years.

Part I—Flight Data

Recording of Data

The simplest and most widely used method for recording data during a flight test is by means of the photographic observer. This method utilizes a special instrument panel containing the test indicators which are photographed by a camera whenever data are to be recorded. In this manner simultaneous readings of all instruments may be obtained with a minimum of flight personnel. Fig. 1 shows a typical flight record taken with such an observer. This picture, showing 44 readings, was taken at an acceleration of 8.9 *G* and at an indicated airspeed of 468 mph. during a rolling pull-out from a dive.

The use of a catadioptric panel has proved to be of great advantage in overcoming the problem of glare and reflection from the instrument faces. The construction of this observer consists of a transparent plastic mask placed over the front of the instrument panel. Holes with beveled edges are cut for each instrument, and lights imbedded throughout the mask evenly distribute the light to all instruments through the plastic. A slight increase in size is required for such a panel for good light distribution. The photograph, Fig. 1, was made with this type of panel.

Best results are obtained using a 35-mm. motion-picture camera with a long focal length lens to photograph the panel. Since space limitations usually prevent the use of a lens with a focal length over 1½", some parallax often occurs at the corners of the panel. Instruments requiring less accurate readings are usually placed at these points, but for precision readings of all instruments the panel may be slightly concave to enable each instrument to be perpendicular to the line of sight to the lens. Satisfactory pictures of 36 instruments have been made with a 16-mm. camera, and 72 instruments with a 35-mm. camera under flight conditions.

The comments of the pilot and test observers have been found to be of considerable value in the interpretation of data secured during test flights. For this reason, the use of a magnetic wire recorder on all test flights has become a standard procedure. The wire recording, containing all crew conversation, visual readings of miscellaneous instruments and comments on the functioning of the airplane, presents an excellent means of correlating data and evaluating the test information.

Pressure Measurements

Aircraft pressure measurements, used to define pressure and flow characteristics on aircraft components, present considerable difficulty to the engineer. Not only must the proper pressure head be selected, but a satisfactory method of recording each pressure must be devised, particularly when a large number of pressures are to be measured.

Fig. 2 shows the 85 altimeters used on the A-30 airplane for a study of airfoil characteristics at high subsonic speeds. In this program, the absolute pressure is measured at a number of orifices on an airfoil and in its wake during high-speed dives. Since simultaneous readings are a necessity, three motion-picture cameras photograph the altimeters continuously to obtain the necessary data. Altimeters were chosen for use on this project to provide necessary accuracy over the wide range of pressure encountered. Careful studies of the effect of instrument lag and line lag were made, showing that the rate of change of pressure during a given dive did not introduce serious errors in the measurements. The external appearance of the airplane with the airfoil and the drag rake installed in place, is shown in Fig. 3.

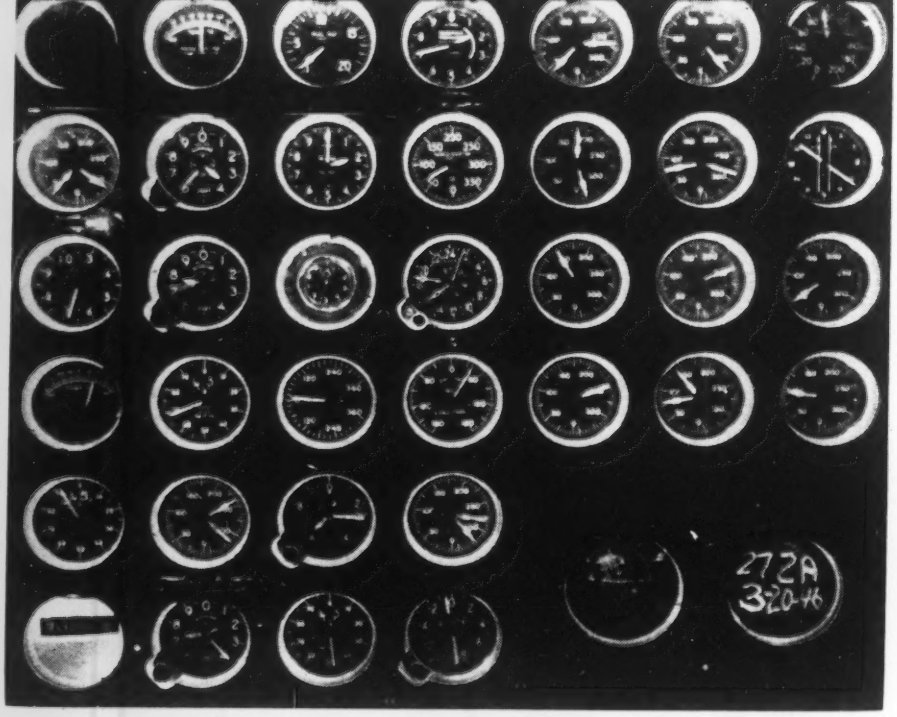


Fig. 1. Typical Photo Observer Record.

*Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Penna., Sept. 16-20, 1946.

Note: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

It is apparent that the system using a separate gage for each pressure, as used on the A-30 airplane for high-accuracy simultaneous measurements, will not be satisfactory for general cooling and airflow determinations. The number of gages and the large space necessary for the gage installation prohibit the application of this method for normal tests.

For the major part of the testing at the Martin Company, a pressure-selecting system has been used with considerable success. In this device, a series of automatically-controlled solenoid pressure switches switch differential pressure gages from one source to the next. The schematic diagram of this system is shown in Fig. 4. The gages are connected to the solenoids by manifolds. In the illustration, four pressures are to be read by each gage. Consequently, every gage manifold has four electrically-operated solenoid valves, each shutting off a pressure source. The four solenoids are controlled by a rotary selector switch which energizes solenoid A in banks 1 through 4, applying pressures P_{1A} through P_{4A} to the respective gages. After the data have been taken from these sources, the selector switch is rotated to the B bank, and the pressures P_{1B} through P_{4B} are in turn applied to the gages.

By stepping the selector switch with an intervalometer and appropriate control circuits, the entire function is automatized. Upon closing the sequence switch, the system is idle for a period of time varying from 4 to 8 seconds to allow the pressure at the gages to stabilize. This stabilization time is determined experimentally for each installation, and this interval is set on the intervalometer for all pressure measurements. A picture of the intervalometer control and sequencing switch is included (Fig. 5). At the end of this interval, the gages are photographed by a camera, and the switch is impulsed to the next point, where the process is repeated. At the final point, the stepping switch locks in place with an indicator lighted showing the pilot or remote observer that the sequence is complete, and the next condition may be investigated.

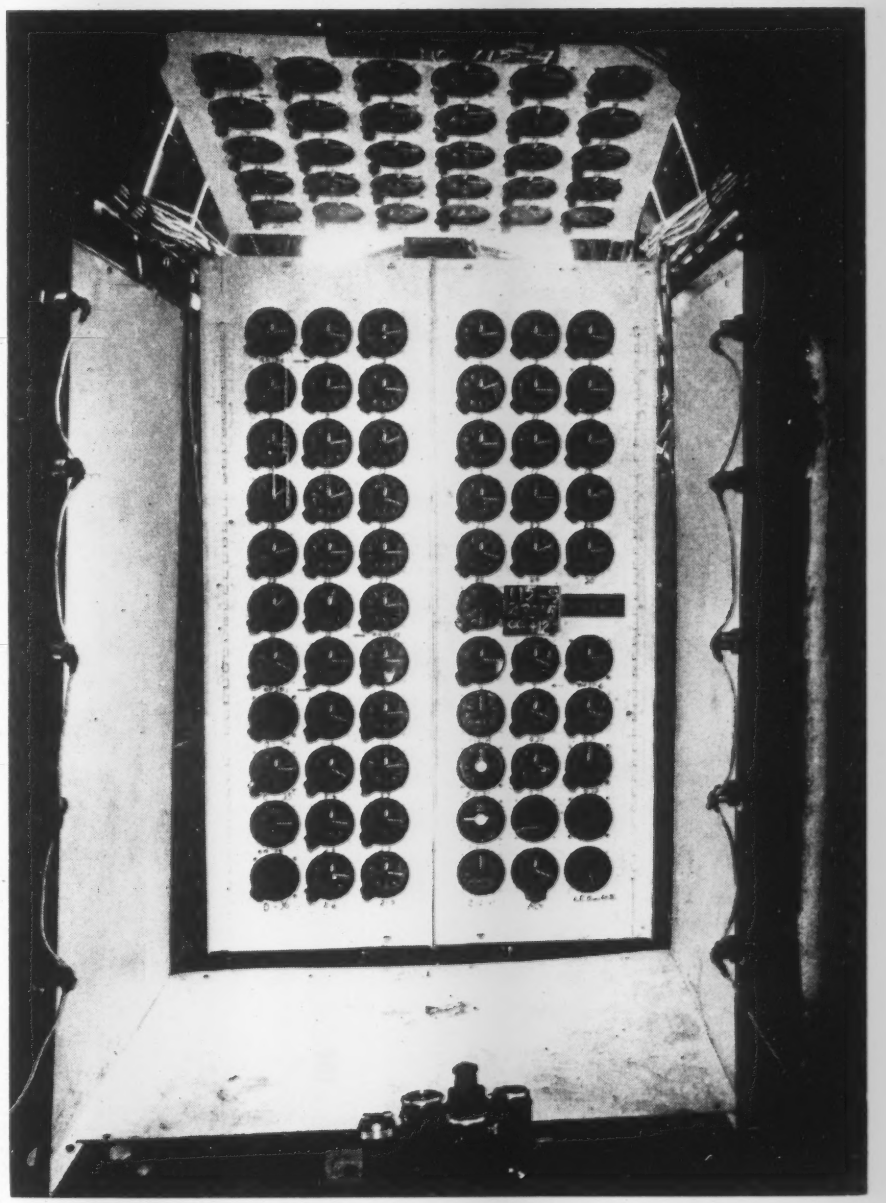


Fig. 2. Photographic Observer for Pressure Measurements. One of the three motion-picture cameras may be seen.

The versatility of this system presents remarkable opportunities for testing applications. Any number of pressures may be recorded with such a system at a rate up to 100 pressures per minute. A standard size of 14 gages and 12 selector switch points, allowing 168 pressure measurements, has been in continuous use at the Martin Company over a period of years with considerable success.

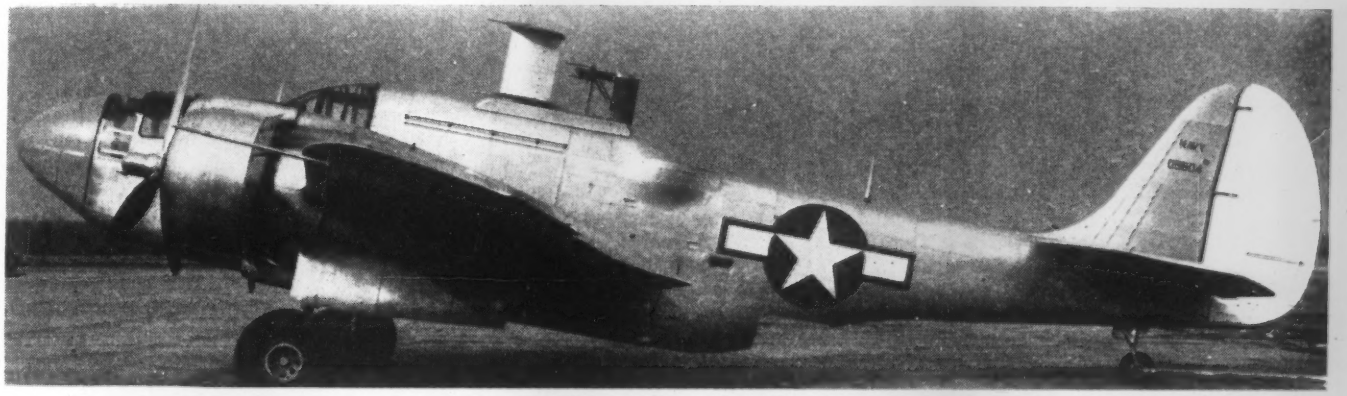


Fig. 3. External Appearance of Airfoil Test Airplane.

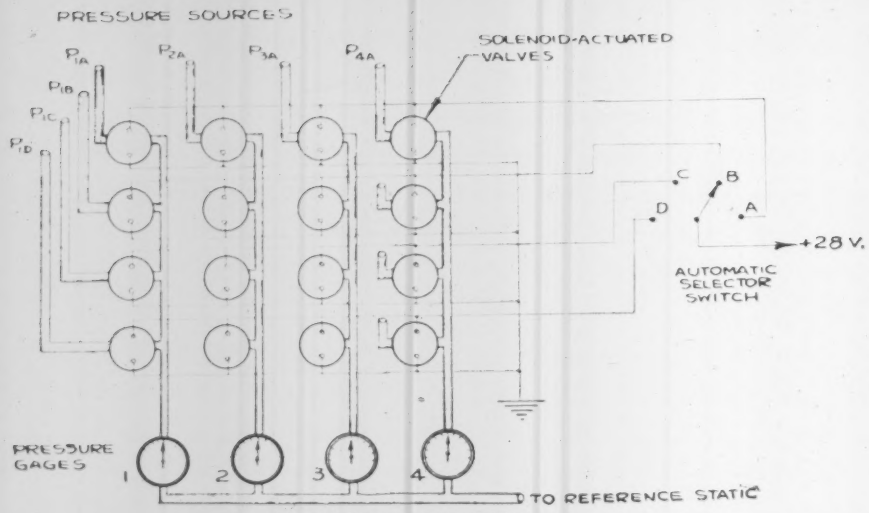


Fig. 4. Pressure Selector Mechanism.

Fig. 5. Automatic Sequencing Switch and Impulse Intervalometer Control.

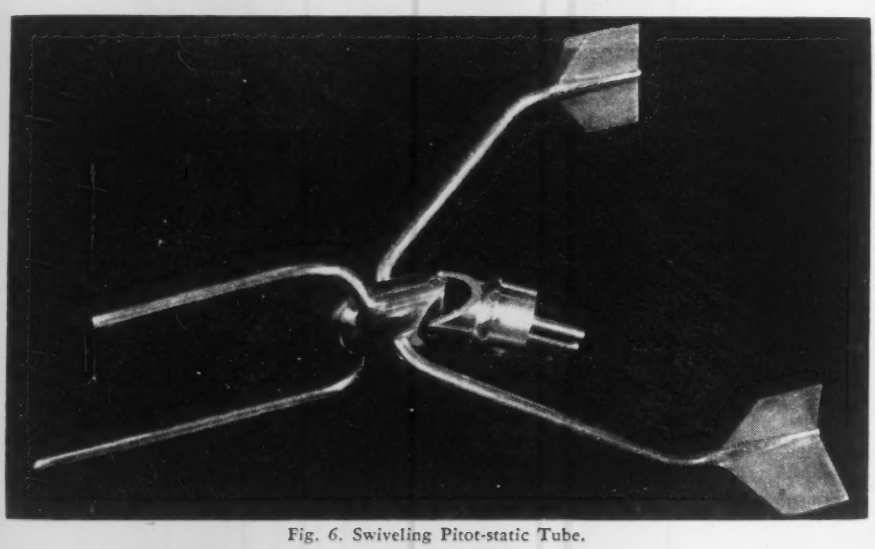


Fig. 6. Swiveling Pitot-static Tube.

Airspeed Measurements

The conventional airspeed measurements are made by the mechanical solution of the equation:

$$P_{\text{Total}} = P_{\text{Static}} + P_{\text{Impact}}$$
$$= P_{\text{Static}} + \tfrac{1}{2}\rho V^2$$

The values of P_{Total} and P_{Static} are measured by the use of appropriate Pitot and static tubes and the solution of the equation is performed by the airspeed indicator. Since the value of ρ is neglected, the resultant velocity is known as the *indicated airspeed.*

The value of the observed pressures may be in error owing to local increases in flow velocities over the static orifices or changes in the angle of attack or angle of yaw of the airplane.

A test reference airspeed system using a swiveling Pitot-static tube as shown in Fig. 6 is used to reduce errors from these sources. This instrument is mounted on a boom extending approximately one chord length ahead of the wing of the airplane where the flow is relatively undisturbed by the airplane. The vanes on the head keep it aligned at all times with the local flow direction, and permit comparison of the test airspeed system with the service systems.

It is often found that the static pressure given by such an instrument is not exactly equal to the true free-stream static. For this reason, airspeed calibrations are made to determine the exact corrections to the indicated speeds. Calibrations are made by (1) use of a trailing static bomb to get the true free stream static in the undisturbed air, (2) flying the airplane over a speed course and (3) pacing the airplane with an airplane having a known airspeed calibration.

The use of the static bomb is shown in Fig. 7, depicting the XBTM-1 airplane towing an automatic bomb. This bomb is lowered or raised by remote control from the pilot's cockpit, and has been towed at speeds up to 330 mph. When raised, the bomb rests in chocks beneath the airplane fuselage.

The speed course, with many variations, is one of the most satisfactory means of obtaining the airspeed calibration. Care must be exercised by the pilot to make sure that no change in altitude occurs during the run, and passes over the course must be made in each direction to average out the effects of the wind. Speed course runs have been made at medium altitudes through the use of radio marker beacons which trip timers when the airplane passes through the beacon. Similarly, variations of radar technique have been used and have given results of varying accuracy, depending on the sharpness of the antenna radiation pattern. The disadvantage of all speed-course methods lies in the fact that accurate calibrations cannot be made at speeds above the maximum level flight speed of the airplane. With particular care and at low altitudes, short speed runs may be made

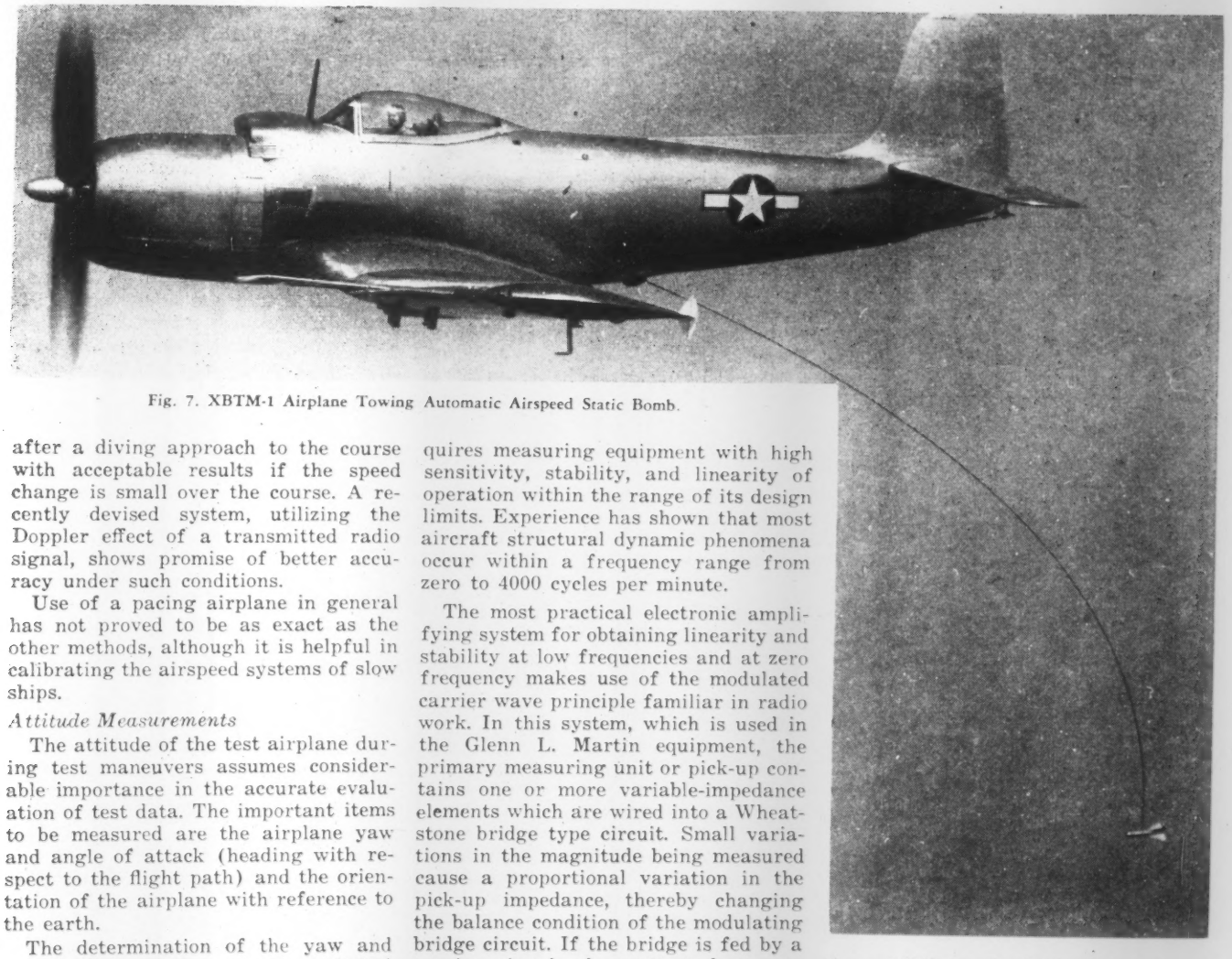


Fig. 7. XBTM-1 Airplane Towing Automatic Airspeed Static Bomb.

after a diving approach to the course with acceptable results if the speed change is small over the course. A recently devised system, utilizing the Doppler effect of a transmitted radio signal, shows promise of better accuracy under such conditions.

Use of a pacing airplane in general has not proved to be as exact as the other methods, although it is helpful in calibrating the airspeed systems of slow ships.

Attitude Measurements

The attitude of the test airplane during test maneuvers assumes considerable importance in the accurate evaluation of test data. The important items to be measured are the airplane yaw and angle of attack (heading with respect to the flight path) and the orientation of the airplane with reference to the earth.

The determination of the yaw and angle of attack can be accomplished most easily by the use of the instrument shown in Fig. 8. This unit consists of a small vane geared to a self-synchronous position transmitter and mounted on a boom ahead of the airplane. The position of the vane, aligned with the relative wind, with respect to the airplane axis gives a direct indication of the yaw or angle of attack. By gearing the vane to the transmitter with a 1:10 ratio and calibrating the instrument in a wind tunnel, good accuracy may be obtained.

To ascertain the pitch and roll of the airplane with respect to the earth, a gyroscopic instrument of the free type is used. An attitude gyro unrestrained in roll or pitch may be used for direct reading. For good accuracy, the gyro positions are taken from the gimbals and remotely indicated with a suitable instrument. This may be accomplished either by direct pick-off with a low-friction self-synchronous system or by means of a variable-impedance pick-up coupled to an amplifier.

Part II

Dynamic Load Measurements

The general problem of measurement of dynamic loads encountered in aircraft and their component parts requires measuring equipment with high sensitivity, stability, and linearity of operation within the range of its design limits. Experience has shown that most aircraft structural dynamic phenomena occur within a frequency range from zero to 4000 cycles per minute.

The most practical electronic amplifying system for obtaining linearity and stability at low frequencies and at zero frequency makes use of the modulated carrier wave principle familiar in radio work. In this system, which is used in the Glenn L. Martin equipment, the primary measuring unit or pick-up contains one or more variable-impedance elements which are wired into a Wheatstone bridge type circuit. Small variations in the magnitude being measured cause a proportional variation in the pick-up impedance, thereby changing the balance condition of the modulating bridge circuit. If the bridge is fed by a carrier signal of constant frequency and voltage, the bridge output signal will be proportional to the change in the quantity being measured.

Fig. 9(A) demonstrates the action of the bridge modulating circuit where the magnitude being measured controls the impedance *A* which acts like a sensitive valve in passing more or less of the carrier voltage to the bridge output.

The modulated carrier is amplified and transformed by means of a full-wave rectifier into a pulsating unidirectional current of twice the carrier frequency. The envelope of this pulsating current is proportional to the variation in *A*, as shown in Fig. 9(B). The envelope current is fed to a galvanometer coil in a recording oscillograph which makes a permanent photographic record of that envelope by means of a light beam deflected by the galvanometer mirror. Thus, the over-all result is a record trace whose displacement is proportional to the magnitude being measured. The carrier wave is introduced only to facilitate amplification of the pick-up signal which may be of low or zero frequency. It is eliminated after the amplification is obtained, but its use is amply justified.

Design and construction of the equipment must minimize or eliminate the effects of severe impact, shock, battery

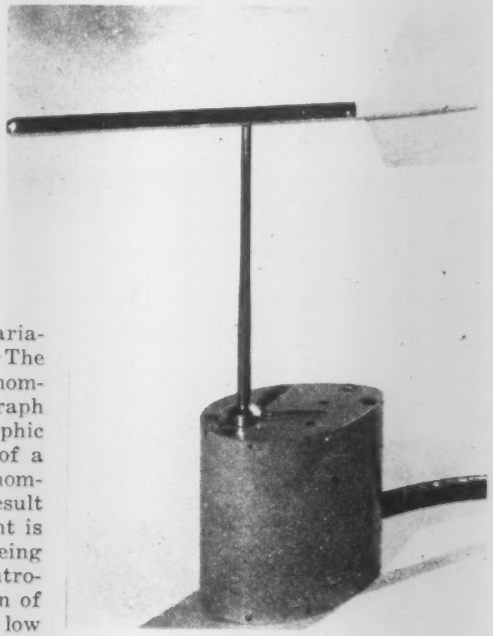


Fig. 8. Yawmeter.

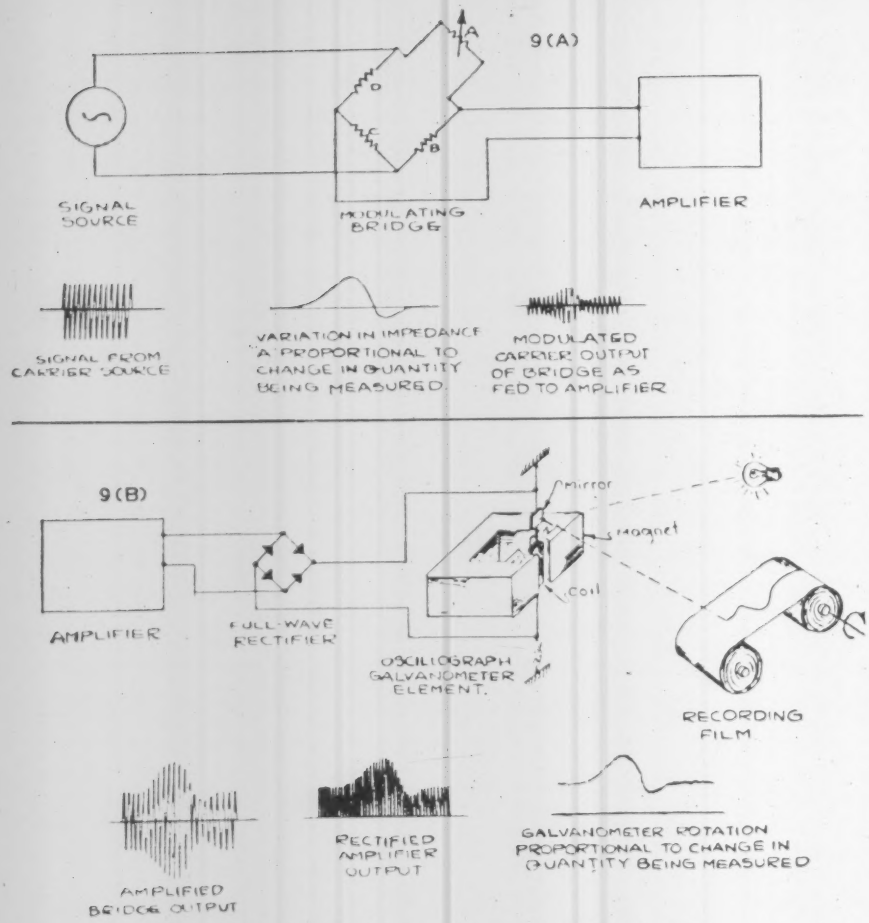


Fig. 9. Basic Principles of the Carrier System as Applied to the G.L.M. Dynamics Measurement Equipment.

input voltage variations, and extreme temperature variations. Rugged mechanical construction, non-microphonic vacuum tubes and voltage stabilization circuits are used to realize satisfactory performance under such conditions.

With such equipment, accurate measurement may be made of rapidly-varying accelerations, strains or positions. Pick-up units, utilizing variable-impedance devices, metaelectric strain gages, photocells, or similar items may be constructed with any desired range and sensitivity. Simultaneous recording of a number of pick-up outputs on multi-element oscillographs enables accurate test evaluation.

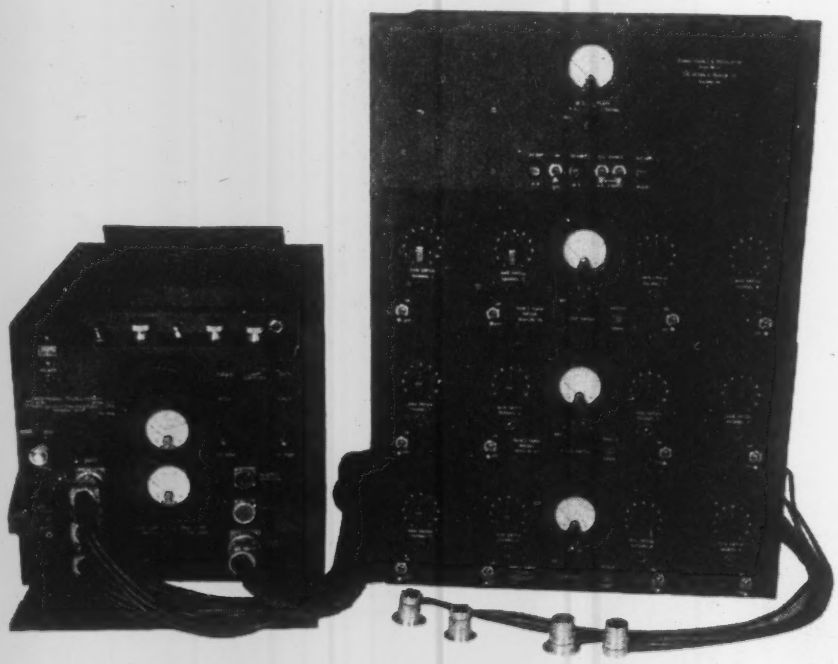


Fig. 10. Dynamics Measurement Equipment.

Although the majority of dynamic phenomena are within the range of 0-4000 cpm., as mentioned above, the engineer is often confronted with the problem of measurements above this frequency range. Structural investigations on exhaust collector systems, landing gears, hull bottoms and control surfaces frequently require measurements up to 2000 cycles per second or above. Flight within the transonic or supersonic regions may impose large rapidly-varying aerodynamic loads requiring measurement within the higher frequency ranges.

The amplitude-modulated carrier system may be used for such measurements if the proper carrier frequency is selected and necessary precautions are taken to prevent excessive capacitance losses in the pick-up leads. However, a frequency-modulated system proves to be more adaptable to this measurement problem. In using a FM system, losses and changes in amplitude are made less important, and the equipment becomes more adaptable for radio telemetering.

Telemetering becomes a necessity when testing radio-controlled aircraft and is of great advantage in certain conventional aircraft tests. The radio transmission of a number of channels of information may be accomplished by allowing each pick-up unit to modulate an individual sub-carrier, which in turn modulates the radio-transmission carrier frequency. At the ground receiving station the individual sub-carriers are filtered out, demodulated and recorded.

Inter-modulation effects restrict the usefulness of the sub-carrier system to a relatively small number of channels. A larger number of channels may be handled successfully by a commutator system. The output of each pick-up is commutated to the transmitter at a high rate, so that a single radio carrier conveys the information to the ground station. At the receiver, a similar commutator, synchronized with the transmitting commutator, separates the data for recording purposes.

The advantages of telemetering systems indicate that such equipment can be successfully utilized for the measurement of many aircraft data otherwise unobtainable. For this reason it is imperative that concentrated effort be made to develop telemetering systems to be a reliable and efficient testing tool.

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Spectroscopy in the Petroleum Industry*

By S. C. FULTON and J. J. HEIGL, Esso Laboratories, Elizabeth, N. J.

RAPID progress has been made over the past few years in the application of spectroscopy to the analytical problems currently encountered in both research and process control in the Petroleum Industry. Taking infrared spectroscopy as an example, there were only one or two spectrographs in petroleum research laboratories before 1940. Today, it is estimated that there are more than 100 infrared spectrographs in all kinds of service in both industrial research and process control laboratories. The same is true for ultraviolet absorption, Raman and mass spectroscopy. Their chief value is in providing means for making rapid analyses, both qualitative and quantitative, of highly complex hydrocarbon mixtures. Spectrographs are also becoming important for the direct control of processes by installing modified laboratory type instruments in refinery units.

Before discussing instruments found to be suitable for application to petroleum refining it is desirable to review what has been accomplished and to discuss in general how spectroscopy is used in analysis.

I. Present Status

What can be done with spectroscopy in the analysis of hydrocarbons is at present much more limited by the lack of availability of pure hydrocarbons for calibration and determination of spectral characteristics than by the status of instrument development. This was recognized early in the war and a cooperative program was set up by the National Bureau of Standards and the American Petroleum Institute to prepare and purify the most necessary hydrocarbons. As of May 15, 1946, some 90 hydrocarbon standards of high purity have been prepared and can be purchased from the Bureau. By making use of these samples and others, it now is possible to analyze for all the paraffins boiling up to 260°F. and all aromatics boiling up to 350°F. In the case of naphthenes, olefins, diolefins and other hydrocarbons the picture is not so bright since only relatively few have been synthesized and purified. Many mixtures, however, containing certain of these compounds for which standards are available can be readily analyzed. Table I summarizes this information for both gases and liquids, indicating the spectrographic methods most commonly used for the analyses.

In addition to the analysis of hydrocarbons, a number of analyses for the elements are required in the petroleum industry, as in work on development of catalysts for hydrocarbon conversions and determination of nature and amount of salts in crude oils. Analytical methods based on emission spectroscopy have been found to be very useful in these problems and a number of analytical procedures are available based on emission spectra. Elements such as iron, potassium, sodium, vanadium, copper, lead and the like can be both identified and measured quantitatively.

II. General Principles

All electronic, atomic and molecular vibrations, of which light waves are an example, are electromagnetic in nature. The electromagnetic spectrum includes all waves of this type and arranges them in the order of increasing wavelength. Referring to Fig. 1 they begin from the shortest gamma rays (radiation of shorter wavelength occurs) through x-rays, ultraviolet, visible and infrared light to radio waves and beyond. The visible spectrum has the smallest wave-length interval, extend-

TABLE I. PRESENT STATUS OF HYDROCARBON ANALYSIS

Hydrocarbon Class	*Present Analyzable Range*	*Methods of Analysis*
Paraffins	Through compounds containing eight carbon atoms. Some compounds containing nine carbon atoms.	Distillation, Infrared, Raman, Mass.
Olefins	Through compounds containing five carbon atoms.	Distillation, Infrared, Mass, Raman.
Aromatics	Through compounds containing nine carbon atoms. Some compounds containing ten carbon atoms.	Distillation, Ultraviolet, Infrared, Raman, Mass.
Naphthenes	Some cyclopentanes and cyclohexanes.	Distillation, Infrared, Raman.

*Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Penna., Sept. 16-20, 1946.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

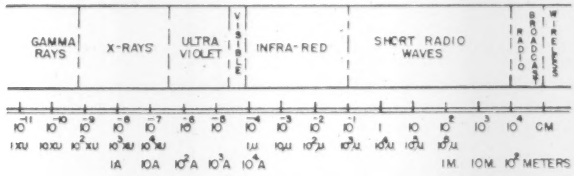


Fig. 1. Electromagnetic Waves.
(From Fundamentals of Physical Optics by Jenkins and White)

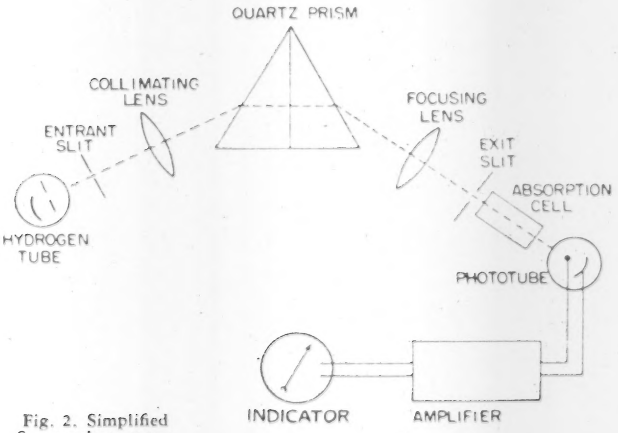


Fig. 2. Simplified Spectrophotometer.

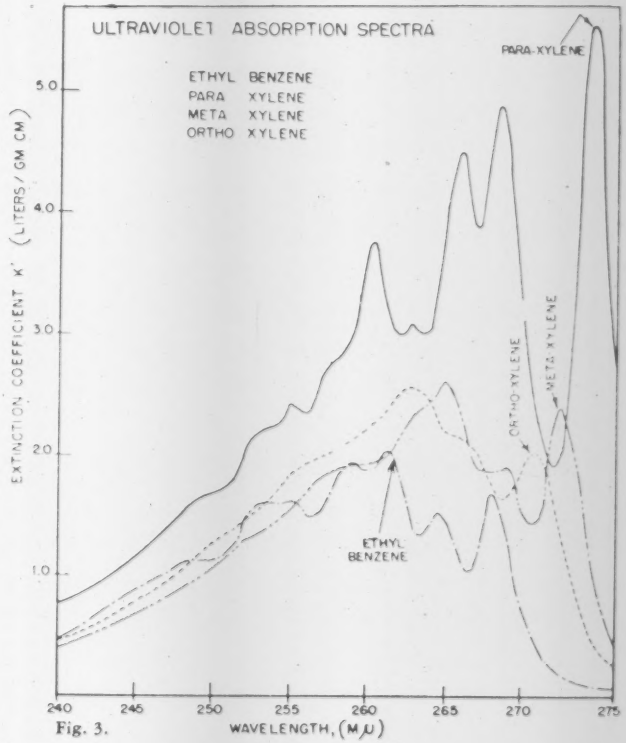


Fig. 3.

TABLE II. DEVELOPMENT OF ULTRAVIOLET SPECTROPHOTOMETRIC PROCEDURE FOR THE ANALYSES OF THE ISOMERIC XYLENES AND ETHYL BENZENE.

Aromatic	Extinction Coefficients —Wave-length, mμ—			
	274.3	272.5	270.7	261.3
Para-xylene	5.63	2.07	2.35	2.99
Meta-xylene	1.67	2.36	1.39	2.01
Ortho-xylene	0.48	1.31	2.00	2.33
Ethyl Benzene	0.072	0.15	0.36	2.01

The following equations are set up with these coefficients:

$5.63X + 1.67Y + 0.48Z + 0.072W = K_1$

$2.07X + 2.36Y + 1.31Z + 0.15\ W = K_2$

$2.35X + 1.39Y + 2.00Z + 0.36\ W = K_3$

$2.99X + 2.01Y + 2.33Z + 2.01\ W = K_4$

X = Wt. Fraction Para-xylene
Y = Wt. Fraction Meta-xylene
Z = Wt. Fraction Ortho-xylene
W = Wt. Fraction Ethyl Benzene

K_1 = Specific Extinction at 274.3 mμ
K_2 = Specific Extinction at 272.5 mμ
K_3 = Specific Extinction at 270.7 mμ
K_4 = Specific Extinction at 261.3 mμ

TABLE III. GENERALIZED SOLUTION

Weight Percent Para-xylene $= 21.87K_1 + 8.82K_3 - 19.92K_2 - 0.88K_4$

Weight Percent Meta-xylene $= 75.37K_2 + 3.99K_4 - 8.10K_1 - 52.08K_3$

Weight Percent Ortho-xylene $= 86.96K_3 - 19.80K_1 - 26.21K_2 - 12.91K_4$

Weight Percent Ethyl Benzene $= 62.03K_4 - 1.48K_1 - 15.35K_2 - 61.85K_3$

ing from about 0.4 to 0.75 microns, representing a very small region of the electromagnetic spectrum. The most useful regions for the analysis of hydrocarbons are in the ultraviolet from about 200 to 275 millimicrons and in the infrared from about 1.5 to 25 microns.

The phenomenon of absorption is one that occurs throughout the electromagnetic spectrum and is the case of materials having color. While most of the hydrocarbons are transparent in visible light, all hydrocarbons absorb light at various wave-lengths in the infrared region and certain hydrocarbons such as aromatics and conjugated diolefins absorb light in the near ultraviolet. This gives rise to the spectrum of the hydrocarbon and each hydrocarbon has a characteristic spectrum which differs in various degrees from those of other hydrocarbons. By means of a spectrograph it is possible to determine the wave-lengths at which light is absorbed and to measure the amount absorbed.

The theoretical relationship between the amount of light removed from a monochromatic beam passing through an absorbing medium and the concentration of the amount of absorbent present is given by Beer's Law. This states that at a given wave-length if I_0 is the amount of light entering the absorber and I the amount leaving the absorber,

$$\log I_0/I = KCL$$

where K is the extinction coefficient, L the length of the cell containing the absorbent material and C the concentration of the material under consideration. With this equation, the amount of absorbing materials in mixtures can be calculated when the extinction coefficients for each material and the fraction of light transmitted at selected wave-lengths are known. The applicability of Beer's Law to analysis depends on how closely the assumptions on which it is based are met. For monochromatic light the extinction coefficient K is a well-defined quantity and no trouble is experienced in using this relationship for the analysis of samples that are free from intermolecular associations or other abnormalities in the molecular groupings present. Spectrographs employed for analysis should be capable of giving as close to monochromatic light as possible. Experimentally it has been found that for most analytical problems it is possible to use the above relationship without any corrections for deviations.

As an example of the method of setting up an analytical procedure, the analysis of the isomeric xylenes and ethyl benzene of ultraviolet spectroscopy is given in some detail. In order to make the required measurements, a spectrophotometer capable of functioning over the desired wave-length region is employed. A very simplified sketch of such an instrument is given in Fig. 2. The essential parts are a light source, means for dispersing the light from the source and a detecting system. In the simplified sketch the light from the source is directed on a lens, through a slit and collimater into a quartz prism. The light transmitted through the prism is focused on another slit, passes through the cell containing the sample, and falls on the detector. For ultraviolet light the continuous spectrum of hydrogen is a suitable source and a phototube a satisfactory detector. The amount of light is measured after suitable amplification of the photocurrent. Actually monochromators suitable for analytical purposes are somewhat more complicated.

In order to set up an analytical procedure based on extinction coefficients the following steps need to be performed (a) measure the spectrum of each pure compound in the sample under investigation, (b) choose by inspection of the spectra the optimum wave-length for measuring each component in relation to the others, (c) set up equations based on the extinction coefficients for the pure hydrocarbons one for each component and (d) solve the equation in a generalized form for each component in terms of the extinction coefficients of the sample.

The spectra of ethyl benzene, para xylene, ortho xylene and meta xylene are shown in Fig. 3 where the extinction coefficients are expressed in liters/gram centimeter.

These coefficients were measured with a Beckman DU Spectrophotometer employing slit widths of 0.3 mm. Inspection of each spectrum in reference to the others indicates that wave-lengths of 274.3, 272.5, 270.7 and 261.3 mμ are useful for the measurement of para-xylene, meta-xylene, ortho-xylene and ethyl benzene, respectively. The coefficients measured at these wave-lengths showed no systematic deviations with optical density and are accordingly treated as constants in the solution of the equations for each of the components. The measured coefficients are listed in Table II.

A generalized solution in terms of the coefficients measured on the analysis sample is obtained by means of determinants and shown in Table III.

The analysis of an unknown mixture of these constituents can now be performed by measuring the extinction coefficients of the sample at the specified wave-lengths, substituting the measured values in the generalized solution and calculating.

In practice it is customary to modify the rigorous treatment illustrated by introducing short cuts for making the procedures as simple as possible.

The same basic principles are utilized in applying infrared spectroscopy to analysis. The spectrometer, however, differs in the optics, source and detector.

The basic principles employed in Raman differ from infrared and ultraviolet spectroscopy. Raman spectra are produced by the scattering of light by molecules which are excited by the light. The amount of light scattered is directly proportional to the concentration of the material causing the scattering. Measurements are made with a monochromater over a wave-length range by observing the light emitted at right angles to the exciting light, which usually is a mercury arc. The intensity of the Raman lines are measured either photographically or photoelectrically.

In spectrochemical analysis employing emission spectroscopy, the element is excited in either an arc or a spark. Under these conditions characteristic spectral lines and bands are emitted for atoms and molecules respectively. The intensity of these lines and bands is directly proportional to concentrations of the emitters and is measured photographically in a spectrograph. Progress is being made in the direct measurement of spectra by photoelectric means.

Mass spectra are produced by the ionization of molecules as electrons are accelerated across the path of the molecules by high potentials. The ions thus produced are sorted as to mass, either by varying the magnetic field at constant accelerating potential or by varying the accelerating potential at constant magnetic field. The quantities of each mass are measured by a collector

plate at which the particles give up their charge. Hydrocarbons give rise to fragmentation which is specific for each compound. The voltages produced at each mass position for the ionized molecule are designated as its mass spectrum and are directly proportional to the number of molecules present. Mass spectrometers designed for hydrocarbon analysis are commercially available.

III. Analysis of Gaseous Hydrocarbons

Wide use is now being made of infrared for the routine analysis of gaseous hydrocarbons. In general, the infrared method of analysis is used in combination with fractional distillation and chemical separation to reduce the number of original components to seven or less. The mass spectrometer is also valuable for the analysis of gases. Although not as accurate as the infrared for the determination of certain constituents, this method has the advantage of being able to analyze much more complex mixtures without preliminary separation. Gas phase analysis utilizing the ultraviolet region is practiced where the percentage of butadiene is desired in gas mixtures containing paraffins and olefins.

Large savings in time required for the analysis of gaseous samples are accomplished by the use of these various spectrographic methods. A typical example of the advantages of the newer technique is illustrated in the analyses of the mixtures of hydrocarbons containing 4 carbon atoms. The results of several synthetic samples analyzed by infrared are given in Table IV, and show that the analytical accuracy is better than ±0.5 numerical percent for all constituents. The time required to complete a single determination of the seven components, including gas handling, instrument time, and calculation is approximately 1.5 hours. This represents a saving of approximately 12 hours over the conventional procedures which the infrared method has largely replaced in our laboratories. The advantages of the infrared gas-phase method of analysis are also realized in the analysis of certain binary mixtures. A saving of approximately 1.5 man-hours per analysis is made in the determination of isobutane-normal butane and isopentane-normal pentane mixtures. In addition to the saving in time, use of infrared for these analyses has the advantage of giving improved accuracy and reliability.

The accuracy and reproducibility of the mass spectrometer when applied to the analysis of complex hydrocarbon mixtures are adequate for refinery control purposes. An economic evaluation of mass spectrometer operation in routine laboratories has shown that, although the initial investment is greater than that for other gas analytical equipment, large savings in cost of analyses can be realized in cases where the number of samples is large and where analytical time must be kept at a minimum. Continual development of procedures and instrumentation is in progress to extend the range and improve the speed, accuracy and reproducibility of this spectrometric technique.

TABLE IV. ANALYSES OF SYNTHETIC SAMPLES CONTAINING C4 HYDROCARBONS

	Syn. #1	*Found-Routine Infrared*				Syn. #2	*Found-Routine Infrared*			
Constituent	Comp. Vol. %	Run 1	Run 2	Run 3	Run 4	Comp. Vol. %	Run 1	Run 2	Run 3	Run 4
Isobutane	13.3	13.3	13.3	13.3	13.5	24.2	24.1	24.0	24.0	24.2
Normal Butane	36.0	36.4	35.8	36.4	36.2	6.1	6.3	6.4	5.9	6.1
Isobutylene	19.8	19.8	19.9	19.9	19.7	10.3	10.4	10.1	10.8	10.0
Butene-1	14.3	14.2	14.3	14.1	14.2	31.6	31.2	32.1	31.7	31.9
Cis-butene-2	11.0	11.0	11.3	10.7	10.7	26.3	26.6	26.0	26.0	26.8
Trans-butene-2	5.6	5.3	5.4	5.6	5.7	0.6	0.5	0.5	0.7	0.1
Butadiene	—	—	—	—	—	0.9	0.9*	0.9*	0.9*	0.9*

*Found by ultraviolet.

TABLE V. DETERMINATION OF ANALYTICAL ACCURACY

Infrared Spectrometric Procedure

Constituent	Volume Percent	Deviation of Infrared Determination from Synthetic Composition: Mean Deviation	Maximum Deviation
Synthetic No. 77			
2,4—Dimethylpentane	29.5	1.1	1.9
2,2,3—Trimethylbutane	14.8	0.5	1.2
2,3—Dimethylpentane	34.2	0.9	1.6
2—Methylhexane	5.0	0.2	0.6
3—Methylhexane	6.8	0.9	1.4
2,2,4—Trimethylpentane	9.7	0.1	0.5
Synthetic No. 79			
2,2,4—Trimethylpentane	29.9	0.6	1.9
2,5—Dimethylhexane	9.9	0.8	1.8
2,4—Dimethylhexane	9.9	0.5	1.5
2,2,3—Trimethylpentane	18.4	0.6	1.2
2,3,4—Trimethylpentane	15.0	1.5	1.9
2,3,3—Trimethylpentane	11.9	0.8	1.5
2,3—Dimethylhexane	5.0	1.1	2.0

TABLE VI. ANALYSIS OF AROMATIC HYDROCARBONS

Aromatic	*B.P. °F*	*Possible Analytical Groupings*
Benzene	176.18	U
Me Benzene (Toluene)	231.12	U
Et Benzene	277.14	U
1,4 Me_2 Benzene (p-xylene)	281.05	U
1,3 Me_2 Benzene (m-xylene)	282.39	U
1,2 Me_2 Benzene (o-xylene)	291.95	U
Isopropyl Benzene (cumene)	306.31	IU
n-Propyl Benzene	318.59	IU
1-Et-3 Me Benzene (m-ethyltoluene)	322.34	IU
1-Et-4 Me Benzene (p-ethyltoluene)	323.69	IU
1,3,5-Me Benzene (mesitylene)	328.16	I
1-Et-2-Me Benzene (o-ethyltoluene)	329.27	I
1,2,4-Me Benzene (pseudocumene)	336.65	I
t-Butyl Benzene	336.38	I
i-Butyl Benzene	343.04	I
s-Butyl Benzene	343.94	I
m-Cymene	347.1	I
1,2,3-Me_3 Benzene (hemimellitene)	349.07	I
p-Cymene	350.78	I
Hydrindene	352.85	I
o-Cymene	352.9	I

U—Analyzed by ultraviolet. IU—Combination of infrared and ultraviolet. I—Analyzed by infrared.

IV. The Analysis of Hydrocarbon Liquids

The analyses of mixtures of hydrocarbons which boil above about 50°F. are being made by infrared, ultraviolet and Raman spectrographic techniques, after a preliminary separation of wide-boiling-range samples into a series of narrow boiling fractions. These methods are being applied in the analysis of paraffins, aromatics, naphthenes and olefins. The qualitative analysis of certain constituents in liquid hydrocarbon mixtures can be made by utilizing correlations between absorption spectra and structural grouping within the molecule.

The accuracy of analyses of liquid paraffinic hydrocarbon mixtures by infrared spectrometric methods is illustrated in Table V, which shows the results for 12 consecutive analyses for two complex synthetic samples. A maximum deviation between synthetic and found value is 2%; mean deviation varies from 0.1 to 1.5 numerical percent.

The analysis of aromatics can be made by ultraviolet, infrared and Raman techniques or combinations of these methods. It is practically impossible to analyze mixtures of this type by means other than spectrographic. In many cases no single spectrographic method is adequate and combination methods are required to give the most reliable results. As an example Table VI contains a list of aromatics for which spectra are available, indicating possible analytical groupings for avoiding interference and the spectrometric method and combinations of methods employed. The choice of these analytical groupings has been based on the separation of compounds having similar

TABLE VII. INFRARED ANALYSIS OF SYNTHETIC MIXTURE OF AROMATICS

	Volume Percent					
	Blend 12		Blend 15		Blend 18	
Aromatic	Syn.	Found	Syn.	Found	Syn.	Found
m—ethyl toluene	20.1	20	16.1	15	20.2	18
p—ethyl toluene	39.6	39	31.4	31	19.8	23
Mesitylene	20.1	21	36.6	38	19.9	20
o—ethyl toluene	—	—	—	—	19.9	19
Pseudocumene	20.2	20	15.9	16	20.2	20

TABLE VIII. RAMAN ANALYSIS OF SYNTHETIC AROMATIC MIXTURE

	Per Cent by Volume	
Hydrocarbon Mixture P	*Synthetic*	*Measured*
m-ethyl toluene	7.6	6.6
p-ethyl toluene	7.4	6.5
o-ethyl toluene	15.4	17.2
n-propyl benzene	47.2	47.3
1,3,5-trimethyl benzene	22.4	22.4
Hydrocarbon Mixture R		
1,3,5-trimethyl benzene	35.2	34.8
n-propyl benzene	15.6	15.9
o-ethyl toluene	17.2	16.6
1,2,4-trimethyl benzene	13.7	13.0
Tert.-butyl benzene	18.3	19.7

TABLE IX. ANALYTICAL TIME AND ACCURACY—SPECTROCHEMICAL METHODS

	Elapsed Time		
Type of Analysis	*Spectrochemical*	*Chemical*	*Accuracy*
Potassium in Catalyst	1 hour	20 hours	±0.1%
Sodium in Catalyst	1 hour	13 hours	±0.005%
Iron, Nickel, Vanadium in Catalyst	1 hour	20 hours	±0.01%
Barium in Oil	50 minutes	24 hours	±0.01%
Calcium in Oil	40 minutes	9 hours	±0.005%

spectra which would interfere with each other in the analyses. The ultraviolet spectrum of toluene, for example, is similar to that of ethyl benzene, making it necessary to separate these two compounds before applying spectrographic analyses. Ultraviolet spectroscopy is used for the benzene-toluene cut and the four isomers containing eight carbon atoms. The ultraviolet spectra of the higher boiling aromatics are, however, not sufficiently characteristic for accurate analyses. Infrared spectra in the 11.8 to 15 micron region are much more characteristic and infrared spectroscopy is used for the remaining groupings except the one containing aromatics boiling from 291.95 to 323.69°F. In this case neither infrared nor ultraviolet spectroscopy alone is entirely satisfactory, owing to the similarity of the ultraviolet spectra of normal and isopropylbenzene and the infrared spectra of ortho xylene and normal propyl benzene. The best analyses have been made by measuring both ultraviolet and infrared coefficients and using these values to calculate percentage composition.

Data showing the accuracy of measurement of the higher aromatics by infrared spectroscopy are given in Table VII. In addition to ultraviolet and infrared, Raman spectroscopy is also highly useful in the analysis of aromatic mixtures. Data illustrating the results obtained by a recording Raman spectrograph employing photoelectric detection are presented in Table VIII.

V. Spectrochemical Analysis

Emission spectrographic techniques are being applied, for example, in the analysis of catalysts and metallic constituents in oils. The quantitative and qualitative examination of these and other materials for metallic constituents has been found to be more accurate and faster than conventional methods for a large number of mixture types. Samples which can be analyzed include solutions, powders and metallic alloys. The accuracy and elapsed time requirements for a number of analyses currently being performed on a routine basis are given in Table IX. The elapsed times for the chemical methods are also given for comparative purposes.

A spectrochemical method in which the material to be analyzed is vaporized by a flame and the spectrum of the flame observed photoelectrically is finding application in the analysis of sodium and potassium. The accuracy of the method is equivalent to present chemical methods. An individual determination can be made in one minute, after the sample has been prepared for aspiration into the flame. This time requirement is less by a factor of many hundredfold over the conventional chemical procedures.

VI. Instrumentation

A few years ago, it was necessary for the laboratories to build their own spectrographic equipment. In some cases it it still necessary to do this but by excellent coöperation between instrument manufacturers and the laboratories the number of commercially available instruments is rapidly increasing. Satisfactory instruments for most applications of infrared, ultraviolet, emission and mass spectroscopy to current petroleum problems are available.

In general practice all types of spectroscopy are less competitive than they are complementary to each other since there are specific cases where each instrument is superior to the others in regard to accuracy and speed. As an illustration of the variety of spectrographic instruments found to be useful in petroleum laboratories, a partial list of instruments in use by the Esso Laboratories Research Division of the Standard Oil Development Company is as follows:

1 Gaertner Infrared Spectrograph
4 Perkin-Elmer Infrared Spectrographs
1 Beckman Infrared Spectrophotometer
2 Beckman Ultraviolet Spectrophotometers
1 A.R.L. Dietert Emission Spectrograph
1 Westinghouse Mass Spectrograph
1 Recording Raman Spectrograph
1 Flame Photometer
1 Baird Infrared Gas Analyzer

In addition to the spectrographs a variety of accessory equipment is used such as A.R.L. Dietert Densitometers, Leeds & Northrup Recording Densitometer, a Consolidated Computer and other miscellaneous equipment.

A large amount of research and development work remains to be done on instrumentation both by users and instrument companies. This can be done most effectively by active coöperation. There are a number of improvements which it would be desirable to incorporate in infrared, ultraviolet, Raman and mass spectrometers.

In regard to infrared spectrographs, among other items, there is room for considerable improvement in the detecting and amplifying systems and in the manufacture of liquid absorption cells.

In ultraviolet, it would be desirable to extend the wave-length coverage down to 160 millimicrons where olefins give characteristic absorption.

Future improvements in mass spectrographs should result by much simplification in design and the manufacture of spectrographs for specific purposes. For example, a spectrograph of limited range from mass 2 to about 72, and of low cost, would find more extensive application in control petroleum laboratories.

The adaptation of laboratory type spectrographic instruments to control instruments suitable for installation on process equipment is an important development problem. Considerable progress has been made but much remains to be done before these methods can be generally applied.

Many more examples could be given by users of spectrographic equipment which would be of value in guiding instrument manufacturers. Great progress in equipment design has been made during the war years and it is anticipated that it will continue.

Scientific Glass Blowing and Laboratory Techniques

By WILLIAM E. BARR and VICTOR J. ANHORN, Gulf Research & Development Company

XI. HIGH-VACUUM TECHNIQUE IN EQUIPMENT PRODUCTION

In scientific research, high vacuum has become a useful tool with which the scientist has solved various problems. In technology, electron-tube production, molecular or short-path distillation, surface area measurements of porous materials, rare-gas tube production and low-pressure studies of chemical reactions are just a few of the numerous applications in which high vacuum has played an important rôle.

The techniques required in using high vacuum are not difficult to master, especially if the fundamental principles are thoroughly understood. Misuse of vacuum systems can be costly; if certain precautions are not taken when systems are constructed, unreliable results will be obtained.

Two basic and fundamental requirements in the construction of a vacuum system are as follows:

1. Construction materials. The system should be made of materials which are capable of holding the desired vacuum.
2. Dimensional details. All connecting lines in the vacuum system should be large enough so that the pumping speed of the vacuum pumps are not reduced.

These two basic requirements are usually the cause of considerable trouble in vacuum systems and consequently a discussion of each is warranted.

Construction Materials

Glass and metals have been the predominant construction materials for vacuum systems. Small laboratory systems are usually constructed from glass and it is toward such systems that the following discussion will be directed. Certain advantages are gained by using glass because anyone who has mastered the fundamental sealing operations can build suitable systems. The relatively low cost of glass, the ease at which glass systems can be changed, and visibility, are added advantages gained by using this construction material. When metals are used, machine shop facilities must be available and consequently the cost of construction will be higher. Metal systems have greater application in large commercial installations.

The plan of a glass vacuum system requires a certain amount of deliberate study. The evacuation problem should be reviewed and from its requirements a proper choice of condensation and forepump can be made. A discussion of matching speeds of these two pumps has already been given. The second consideration of the problem is the application of the vacuum system. If vacua approaching the ultimate vacuum of the pumps are desired, it is good practice to eliminate all stopcocks, ground glass joints (either tapered or flat) and rubber hose connections on the high-vacuum side of the system, i.e., between the apparatus being evacuated and the vacuum pumps. Even though stopcocks and joints are ground to close tolerances, the lubricants for these ground surfaces have a vapor pressure which will in some cases be sufficient to prevent the attainment of high vacuum. The use of stopcocks, joints and rubber tubing between the condensation and fore pump is not as critical if the fore pump can maintain the required forepressure. Some vacuum systems are used to maintain a vacuum in a system which is not necessarily the ultimate vacuum of the pump combination. The evacuation problem then requires that the vacuum be maintained, not by preventing leakage or degassing in the high-vacuum side but, rather, by making the speed of the pumps great enough to pump the required vacuum. In this case it sometimes is impossible to eliminate all stopcocks or ground joints on the high vacuum side. It is good practice, however, to use the minimum number of stopcocks or joints.

The assembly of a glass vacuum system is not difficult if the parts are carefully planned and properly fabricated. All tube ends which are to be sealed should be smooth and square-cut so that when fused they can be perfectly joined. A minimum amount of working the glass is then required. If the ends are not smooth and perfectly joined, pin-holes are frequently obtained.

Leaks in a vacuum system caused by pin-holes are very disturbing and many times render the system useless. Various methods of finding leaks have been used. The simplest (though not the most satisfactory) has been the use of a Tesla coil. These coils are not expensive. It has been the authors' experience, however, that unless such coils are used with discretion, the damage that can be caused will lead to a great deal of work. Unless seals are made with uniform wall thickness, it is possible to punch pin-holes in the glass.

The best method for finding leaks is to use electrical gages as the Pirani[1] or ionization gage.[2] These gages are located between the condensation and fore pumps. The gage is balanced while the pumps are in operation and sections of the system are painted with acetone, carbon tetra-chloride or ethyl alcohol.[3] Vapors are drawn into the system at the pin-holes and are registered by the gage. Directing a stream of a gas, such as hydrogen, over various parts of the system has been used to detect small pin-hole leaks.

Leak detectors employing the principle of the mass spectrometer[4] have been successfully used in detecting leaks in vacuum systems. This instrument is attached to the vacuum system and, as the latter is pumped, a jet of helium is directed over various parts of the system. This gas is drawn through the leak and passes through the mass spectrometer, where a definite recording is made of the gas with this mass. The operator can thus locate the section and the leak in a relatively short time.

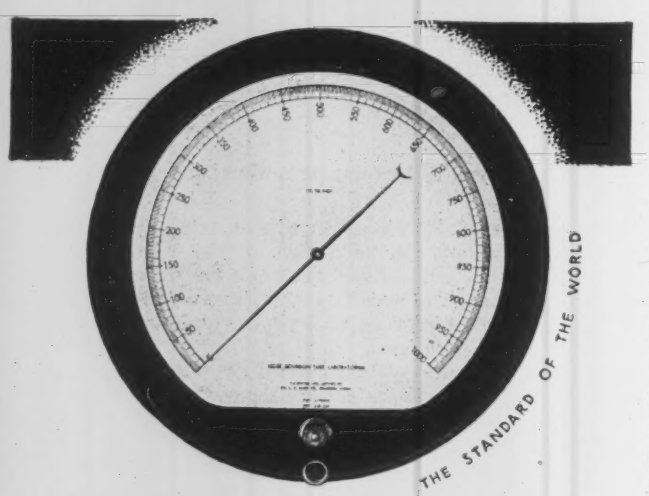
Dimensional Details

One of the most critical parts of a vacuum system is the cross-sectional area of the vacuum lines. Even though the proper choice of condensation pump is made and this pump is matched with a suitable forepump, the rated pumping speed (liters per second) cannot be obtained if the connecting lines are too small. If time is not an important factor and the problem is one of simple evacuation, ultimate pressures can be obtained through small tubes by long pumping periods. On the other hand, when the problem is one of maintaining a certain low pressure in a system where considerable gas must be pumped, one has no alternative but to use lines which are large enough so as not to decrease the pumping speed, especially when the desired speed of evacuation is close to the rating of the pumps. In order to determine or calculate the speeds that can be obtained through various tubes, it will be helpful to review briefly the theory of the flow of gas through a tube and to define pumping speeds of pumps.

Since a vacuum is obtained by actually removing gases from a closed system, it is important that the laws governing molecular motion be known in order that suitable systems can be built for obtaining low pressures.

The work of Robert Boyle and of Edmé Mariotte established the earliest quantitative behavior of gases. The law* derived from their studies states that at constant temperature the product of the pressure and the volume of a given mass of gas is equal to a constant. It can be shown by experimentation that Boyle's law is not exact and that the deviations from the law are slight at low pressures and disappear as the pressure approaches zero. Since low pressures are used in vacuum systems it is satisfactory to use this law.

*Known as Boyle's Law in most English-language texts and as Mariotte's Law in all French and in some other texts.—Editor.



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Avogadro's hypothesis, which states that equal volumes of different gases, at the same temperature and pressure, contain the same number of molecules, has also been shown to be only approximate for actual gases. It is useful, however, to assume its validity when applied to systems at low pressures.

Boyle's law has been shown to be dependent on the temperature. The investigations of Charles and Gay-Lussac have shown the behavior of gas volumes at various temperatures. Data concerning the volume changes show that there are discrepancies among various gases, but that these discrepancies become slight at low pressures.

Combining the gas laws we may write:

$$PV = RT \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

where P = pressure on gas, dynes/cm.^{2}
V = volume of gas, cm.^{3}
R = "gas constant," for the particular gas
T = absolute temperature, °K.

This mathematical expression is known as the *equation of state* or the *characteristic equation* for a perfect gas. It predicts the behavior of an ideal gas and can be applied to actual gases only as the pressure approaches zero. At low pressures, encountered in vacuum studies, it will serve even better than is expected because deviations from the laws become small as the pressure approaches zero.

The kinetic theory states that the average velocity of the molecules of a gas increases as the temperature increases. As molecular velocities increase, molecular collisions are more frequent. If the molecular population is decreased, i.e., decreasing the pressure of a fixed volume of gas, each molecule travels a greater distance before it collides with another. The equation relating this distance, called mean free path, with the molecular population and molecular diameter is:

$$l = 1/(\sqrt{2} \times \pi n \sigma^2) \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

l = mean free path (cm.)
n = number of molecules per cubic centimeter
σ = molecular diameter (cm.)

It will be interesting to note how the mean free path increases with decreasing pressure. If the molecular diameter of nitrogen is taken as 3.13×10^{-8} cm., the mean free paths at various pressures given in Table 20 are obtained by calculation.

TABLE 20. MEAN FREE PATH OF NITROGEN

Pressure (mm. of mercury)	*Mean Free Path (cm.)*
760	8.51×10^{-6}
10	6.47×10^{-4}
1.0	6.47×10^{-3}
0.1	6.47×10^{-2}
0.01	0.647
0.001	6.47
0.0001	64.7

The mean free path increases rapidly with decreasing pressure and, in the usual vacuum range, it can be seen that collisions between molecules are relatively infrequent, whereas molecules collide more frequently with the walls of the confining vessel. The removal of gases from vessels through very small tubes can be expected to be quite difficult. If the resistance to flow of the gas at the end of the tube at the vacuum pump is designated by r, the resistance at the end of the tube of l centimeter length as r_1, and W as the resistance of the tube, the total resistance is given as:

$$r_1 = r + W. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

The opposition to flow is inversely equal to the pumping speed:

$$r = 1/S_0,\ r_1 = 1/S$$

where S_0 = pumping speed at the pump
S = pumping speed at the end of the tube 1 cm. from the pump.

Replacing these values of r and r_1 we have

$$1/S = (1/S_0) + W$$

or $$S = S_0/(1 + WS_0) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

M. Knudsen[5] has shown that the resistance of gas flow through a tube is given by the following equation:

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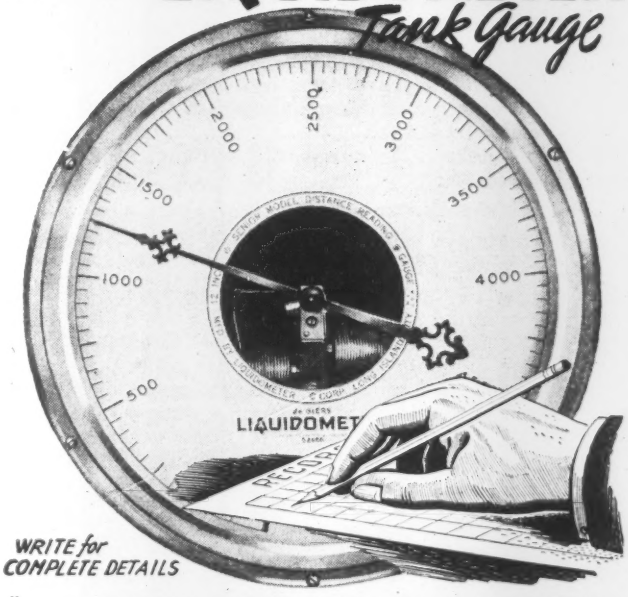

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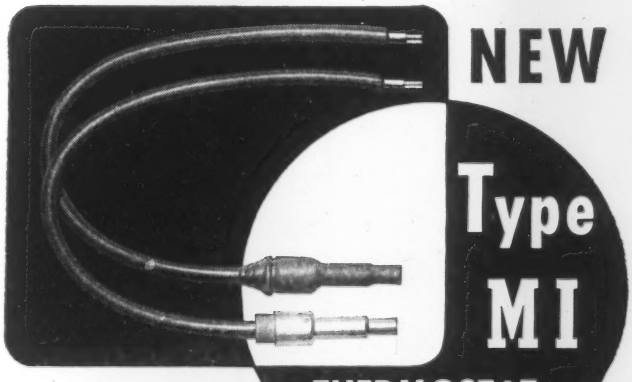

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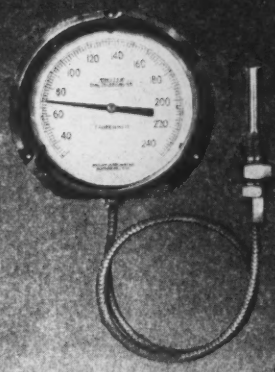

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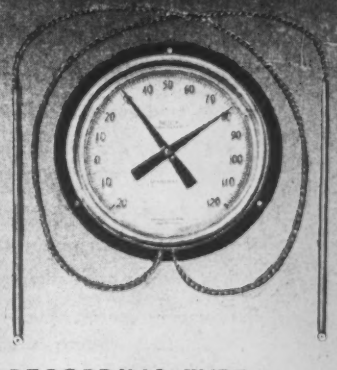

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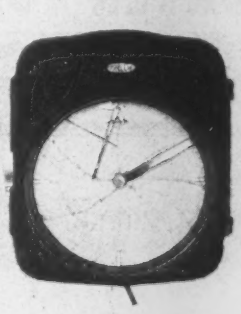

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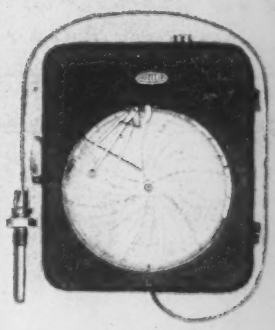

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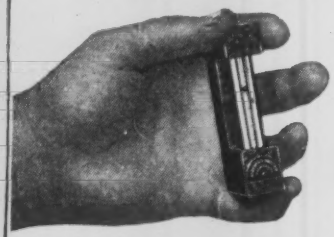

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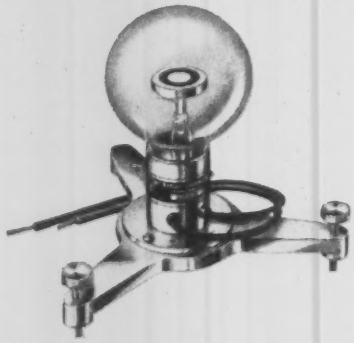

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$$W = 1.59 \times 10^{-5} \left(\frac{273\,M}{T}\right)^{1/2} \left(\frac{l'}{D^3} + \frac{4}{3D^2}\right) \text{sec./cm.}^3 \quad (21)$$

where M = molecular weight of the gas
T = absolute temperature, °K.
l' = length of connecting tube, cm.
D = diameter of tube, cm.

This equation was found to be accurate to within 5% when the ratio of the diameter of the tube and the mean free path was as great as 0.4. The first term in the parenthesis is the resistance of the tube and the second term is the resistances of the two ends of the tube.

When air is pumped through a tube at room temperature equation 21 becomes:

$$W = l''/r^3 \text{ sec./liter} \quad (22)$$

where l'' = length of tube, mm.
r = radius of tube, mm.

The resistances of the two ends of the tube were neglected in obtaining equation 22 and the tube resistance is expressed in sec./liter. This value for W can be used in equation 20.

The effective pumping speed of a condensation pump can be reduced by using connecting lines with small diameters on the high vacuum side. As an example, suppose that the speed of a condensation pump is 10 liters per second at 0.0001 mm. of mercury and that the connecting tube from the pump is 10 cm. long and has a diameter of 1.0 cm. The resistance of the tube is, according to equation 22

$$W = \frac{100}{125} = \frac{4}{5} \text{ sec./liter.}$$

From equation 20

$$S = \frac{10}{1 + 4/5\ (10)} = 1.11 \text{ liters/sec.}$$

The effective pumping speed of the condensation pump is reduced to 1/9 of its rated speed.

The resistances of various different sized sections of a vacuum line are additive. If the line which is illustrated in Fig. 138 is used, a separate resistance for each of the three

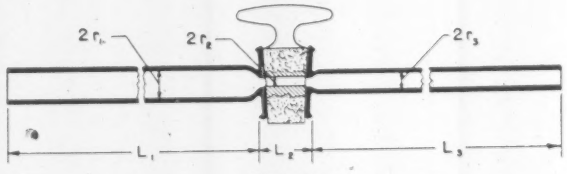

Fig. 138

sections must be calculated. The total resistance of the line is the sum of the three resistances. If $r_1 = 10$ mm., $l_1 = 20$ cm., $r_2 = 1$ mm., $l_2 = 0.5$ cm., $r_3 = 5$ mm., $l_3 = 10$ cm., the total resistance is

$$W = \frac{200}{1000} + \frac{5}{1} + \frac{100}{125} = 6.0 \text{ sec./liter}$$

If the speed of the pump is 10 liters per second the effective pumping speed at the end of the line containing the stopcock is

$$S = \frac{10}{1 + 6\ (10)} = 0.164 \text{ liters/sec.}$$

This example definitely shows that the size of the connecting vacuum lines cannot be neglected if it is desirable to maintain the rated speed of the condensation pump. It is, therefore, good practice to use large and short lines between the condensation pump and the equipment being evacuated, even though it is not necessary to maintain the rated speed of the pump. It can also be shown that if low-speed pumps are used, the resistances of the vacuum lines are not nearly as important as in the case of high-speed pumps.

The speed of a pump is defined as the volume of liquid or gas that passes through the pump in unit time. This definition cannot be applied to a vacuum pump because under pumping conditions a continuous decrease in pressure is obtained in the enclosed system. The speed of the vacuum pump must therefore be defined as the relative rate of de-

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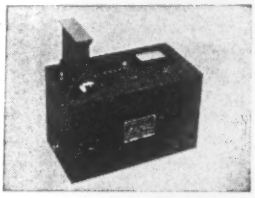

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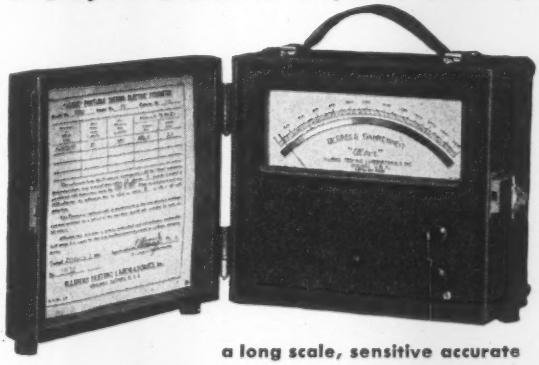

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crease of pressure in a fixed volume. If P_0 is the ultimate pressure limit of the pump and V the volume of the vessel being evacuated, the speed of the pump is defined mathematically as

$$S = -V \frac{dP}{(P-P_0)dt} \quad \ldots\ldots\ldots\ldots\ldots (23)$$

Integrating equation 23 we have

$$S = \frac{V}{t_2 - t_1} ln \left(\frac{P_2 - P_0}{P_1 - P_0} \right) \quad \ldots\ldots\ldots\ldots (24)$$

where P_2 and P_1 are the pressures at t_2 and t_1 respectively.

Equation 24 can be used only for determining the speeds of pumps which have small limiting pressures. If P_0 is small in comparison to P_2 and P_1 it can be neglected and equation 24 becomes

$$S = \frac{V}{t_2 - t_1} ln (P_2/P_1) \quad \ldots\ldots\ldots\ldots (25)$$

which gives the speed of a pump as defined by Gaede.[6]

The pumping speeds of condensation pumps can be determined experimentally by several procedures. The constant-pressure method is applied by using a constant-bleed valve. The volume of gas which passes through the valve is measured at atmospheric pressure. This volume, after pressure conversion, is plotted against time with pressure as the parameter. The method of determining pumping speeds developed by G. C. Eltenton[7] is useful for quick tests of pumping speeds. H. C. Howard[8] has also described a constant-pressure method which is recommended for high speed pumps.

Molecular Thermal Flow

M. Knudsen[9] and G. West[10] have shown that, at low pressures, molecular flow is obtained between two vessels if the temperature of one vessel is different from that of the other. The flow is from the cold to the hot chamber until equilibrium is established. The pressure ratio is given by the equation

$$(P_1/P_2) = (T_1/T_2)^{1/2} \quad \ldots\ldots\ldots (26)$$

where T_2 and T_1 are the absolute temperatures of the two vessels.

The application of equation 26 will be helpful when it is necessary to determine pressures in low-temperature reaction vessels which are maintained at low pressures. As an example: suppose that a vacuum system contains a chamber immersed in liquid nitrogen and that it is desirable to determine the pressure in this chamber. If the vacuum gage is connected to the cold chamber, thermal flow will be obtained to the gage envelope or bulb and the pressure indicated will be in error by $(77.3/298)^{1/2}$ or 0.5 of the gage reading.

Classification of Vacuum Systems

Laboratory vacuum systems can be divided into two classes.[11] The first class, the static system, is used for obtaining the highest ultimate vacuum in various types of equipment. The entire system must be thoroughly out-gassed and be entirely free of leaks. The second class, the kinetic system, is used primarily in systems where pressures of the range 10^{-3} to 10^{-6} mm. of mercury must be maintained. Systems of this class usually have high-speed forepumps and condensation pumps and consequently are used for equipment which, by its nature, cannot be leak-proof. Since each system is used for various problems in scientific research, a description of such systems and techniques involved will be given for each class.

Static Systems

Static vacuum systems are used in investigations which require vacua of the order of 10^{-6} to 10^{-9} mm. of mercury.

Fig. 139

Research in thermionic emission and photoelectric effects are but two of many examples which require a high vacuum. The glass blower finds that a good static system is indispensable in the production of vacuum-jacketed glass equipment.

One of the first and the most important items required in the assembly of a permanent glass vacuum system and yet the most neglected, is a proper method of clamping and mounting equipment. Rack clamps are frequently used. The

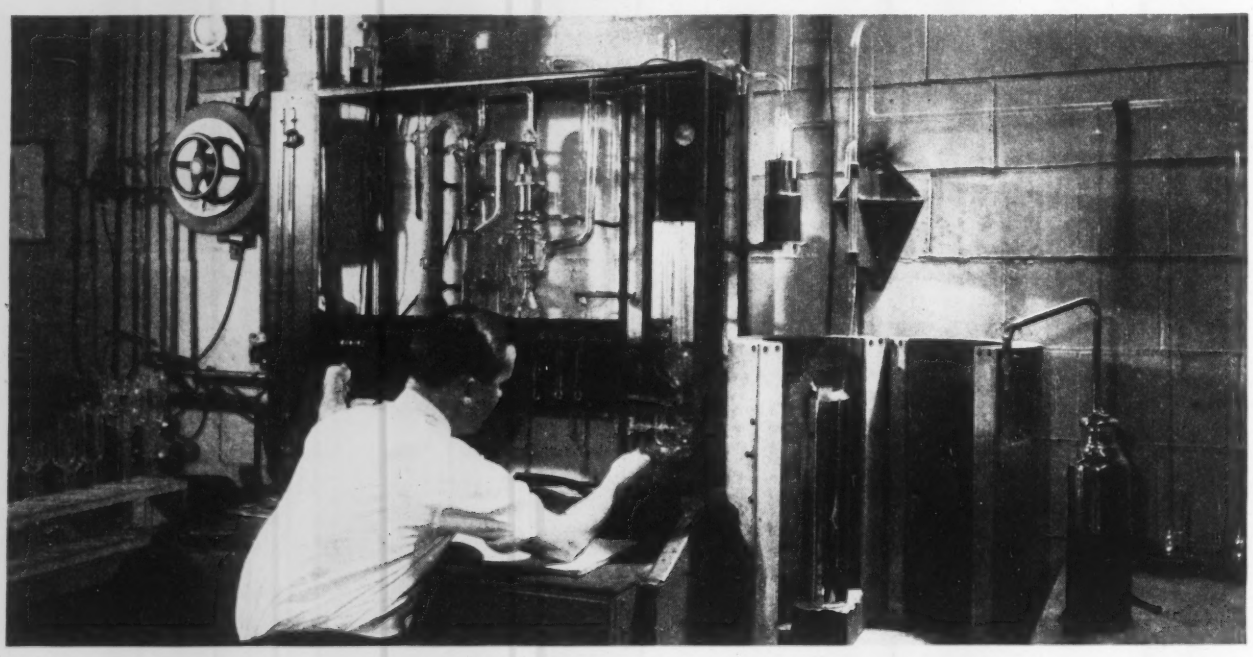

Fig. 140

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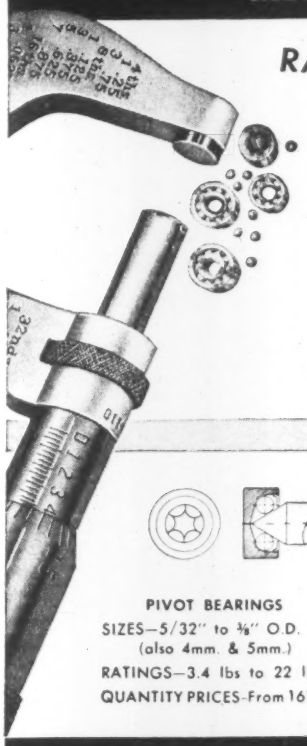

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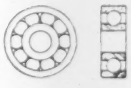

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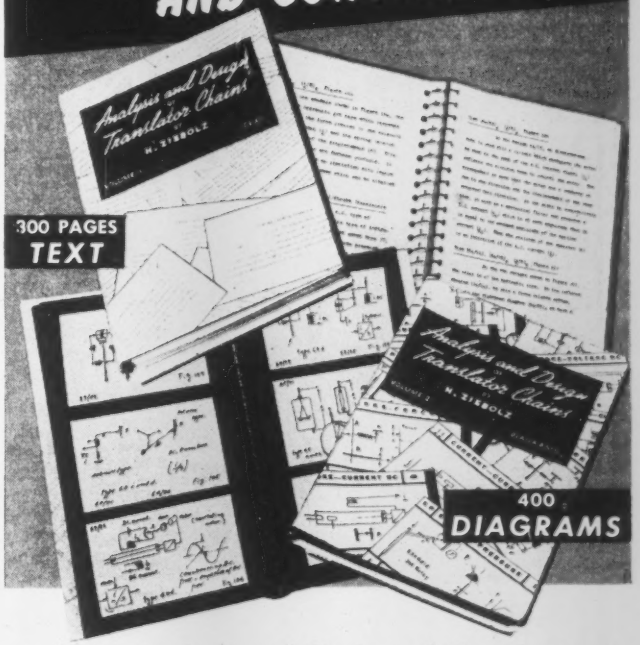

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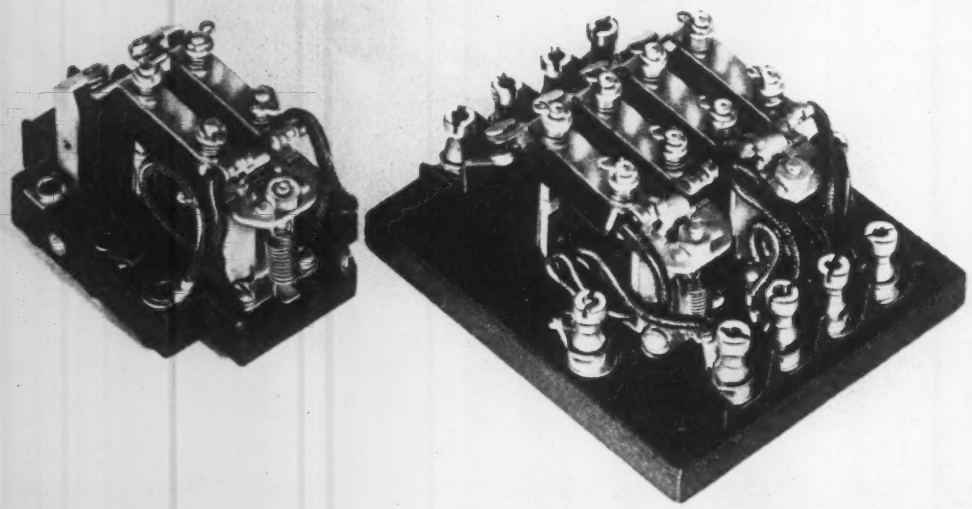

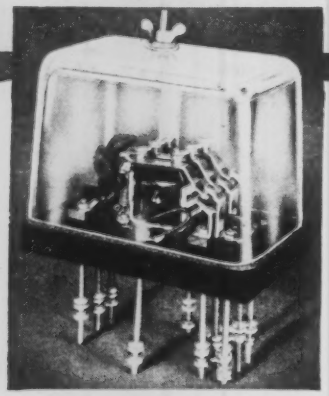

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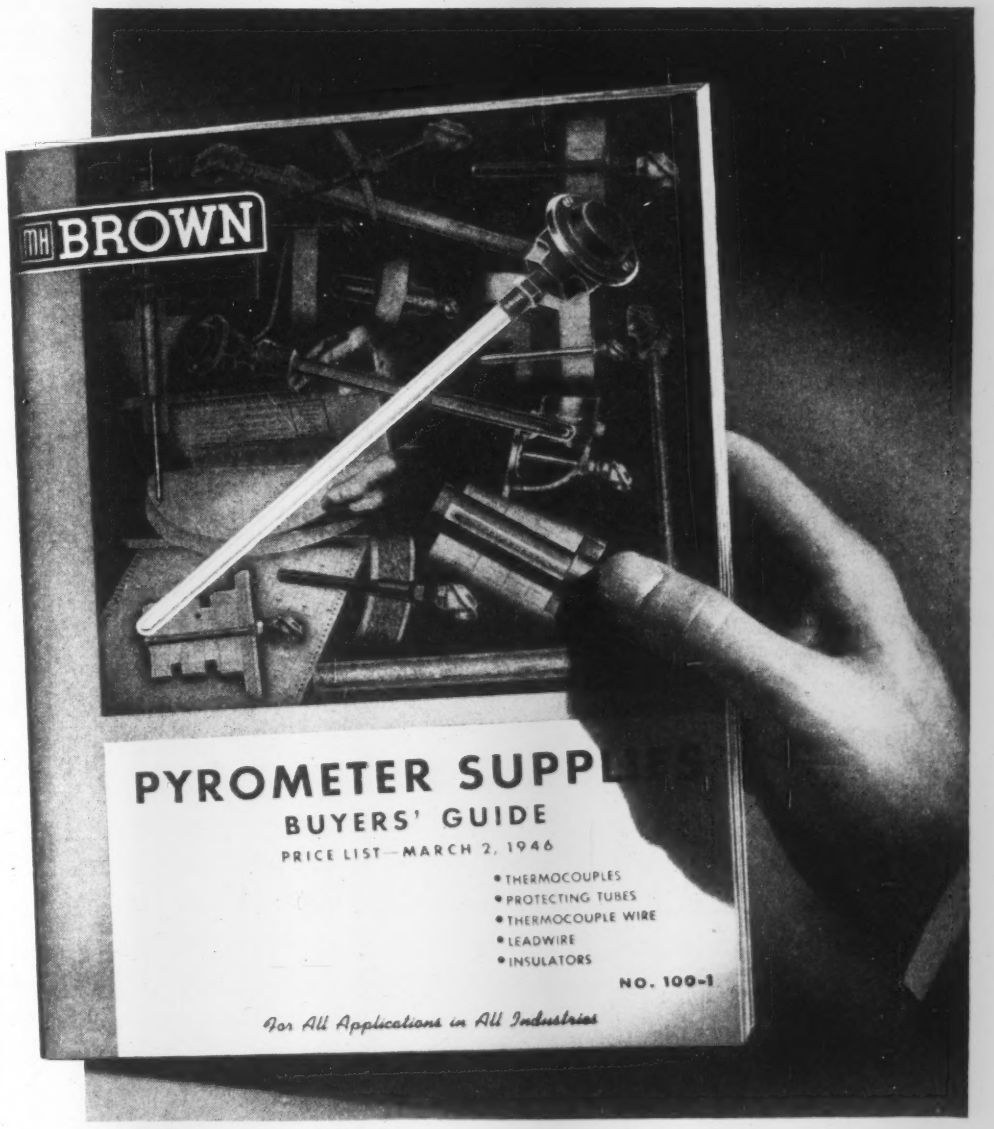

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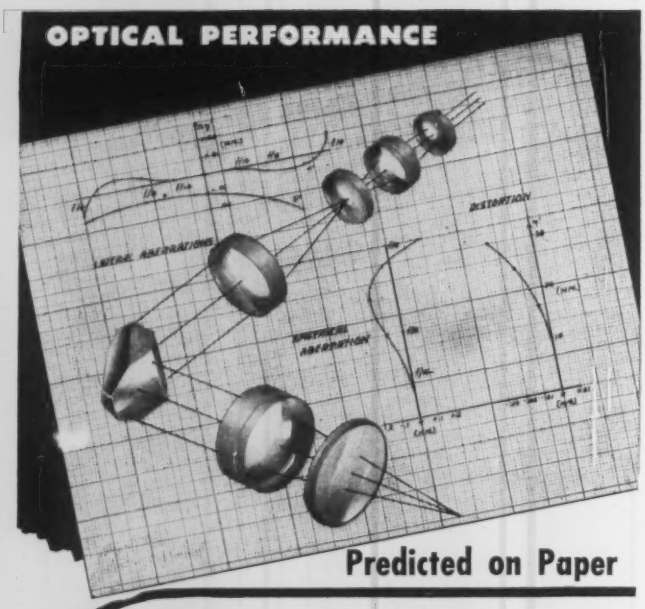

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authors have found that the clamps illustrated in Fig. 139 are most satisfactory and have a neat and compact appearance. These clamps are used with felt or asbestos pads which fit around the glass and serve to relieve strains when the clamp is tightened. The equipment clamps are made of brass or steel and the rod clamps are made of aluminum bar stock. Both are clamped in position with small flat-head screws which fit into the rod clamp. This clamp design allows one to have several clamps very close together on one rod of the rack.

A static system which has been extensively used for obtaining high vacuum is shown in Fig. 140. The clamps discussed above were used for mounting the assembly to the

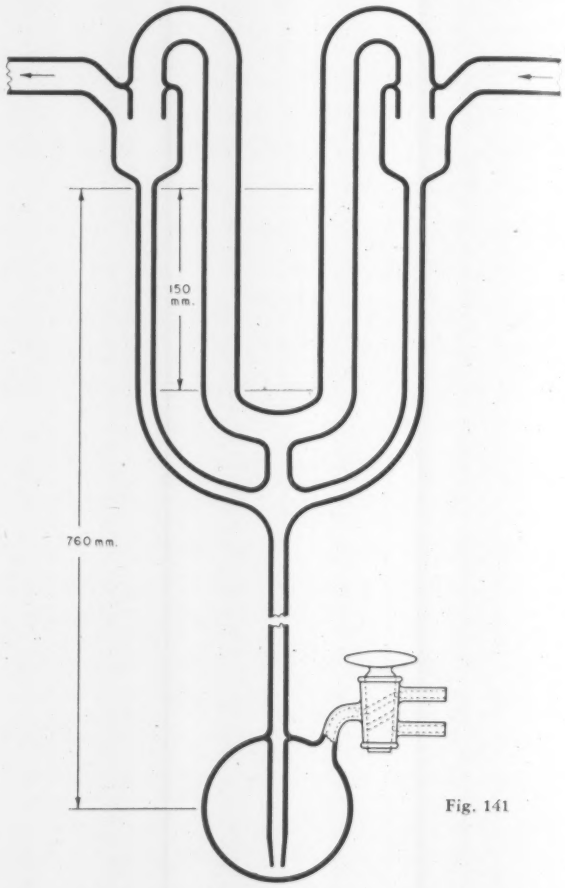
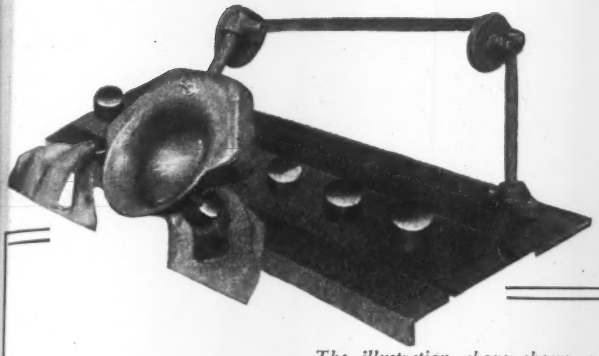


Fig. 141

box rack which is fastened rigidly to the wall. This rack is so arranged that all glass equipment is partly enclosed within the steel framework. All stopcocks are located below the McLeod gage within easy reach of the operator. The system is arranged as follows:

1. The high-vacuum manifold. The high-vacuum manifold extends from the extreme right across the top of the rack and down over the top of the table. Two mercury reservoirs and closed-end manometer filling tubes, previously illustrated in Fig. 122C, are connected to the high-vacuum manifold at the extreme right. A liquid-nitrogen storage Dewar flask, fitted with a silvered and vacuum-jacketed delivery tube, can also be seen at the extreme right. A strip-silvered Pyrex (774) Dewar flask is connected to the manifold. A clamp, fastened to the wall, is strong enough to support large and heavy equipment. A liquid-nitrogen trap is located between the equipment support clamp and the box-rack.

2. The McLeod Gage. The McLeod gage is connected to the high-vacuum manifold just beyond the liquid-nitrogen trap. The gage in this system is the double McLeod gage previously illustrated in Fig. 127B. The glass reservoir to the right of the McLeod gage is connected to the mechanical oil pump through a stopcock. The reservoir can be evacuated by turning two stopcocks and thus vacuum for lowering the



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SM-60	1/100 min.	60 min.	± .02 sec.	$45.00

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THE Standard Electric Time Co.

SPRINGFIELD 2 STANDARD FOUNDED 1884 MASSACHUSETTS

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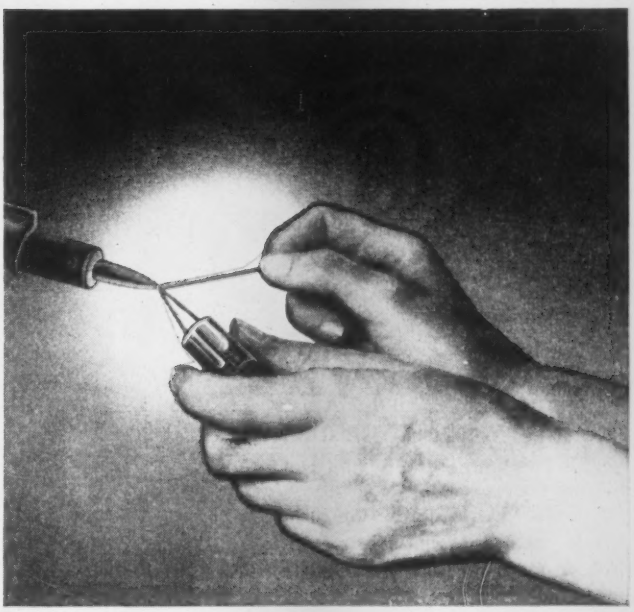

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- Clean, tight solder bonds—solder bonds that hold permanently against twisting, bending, shock, vibration and the expansion and contraction of temperature extremes. That's the solder performance demanded by industry—and the solder performance you get when you use Kester Cored Solders.
- Made for staying power and rugged dependability, Kester Cored Solders are applied in a single, simple operation. The flux-filled cores, scientifically balanced with superior alloys, are your assurance of fast, easy application—virtually mistake-proof solder jobs.
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- The uniform high quality of Kester Cored Solders is backed by nearly half a century of practical experience and exhaustive laboratory tests. Available in a wide range of strand and core sizes, Kester Cored Solders are adaptable to every soldering job. Kester engineers invite your inquiries regarding any solder problems you may have. There is no obligation.

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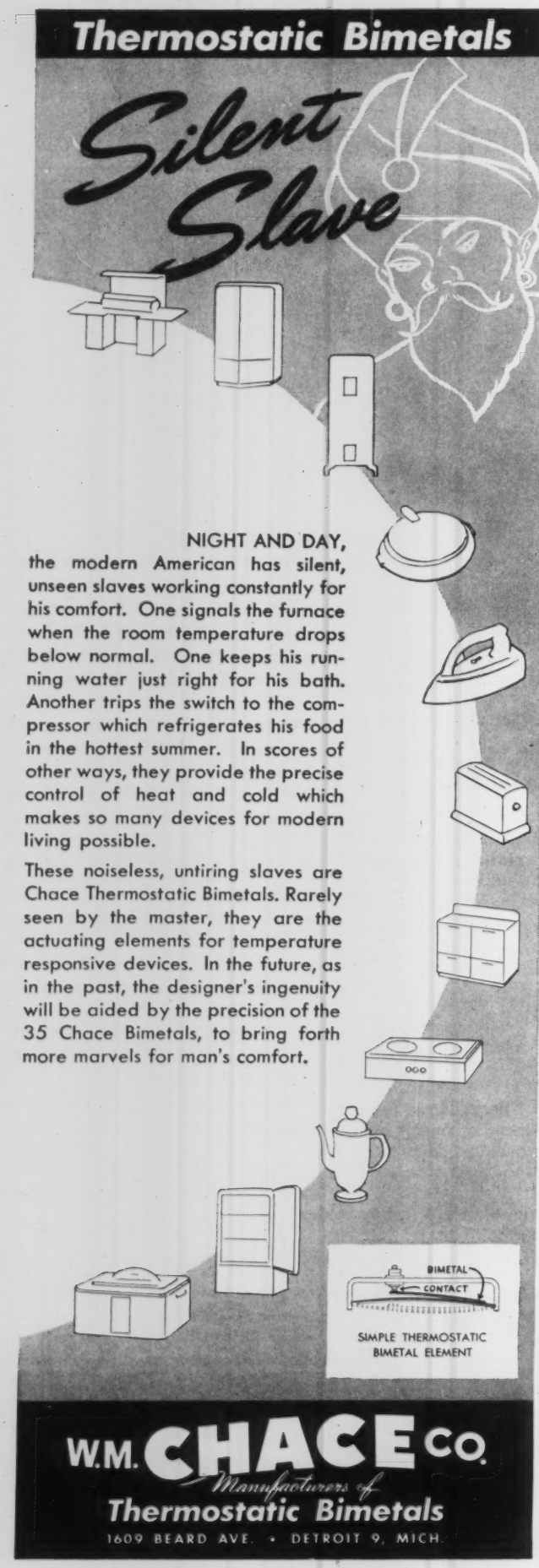
Thermostatic Bimetals
Silent Slave
NIGHT AND DAY, the modern American has silent, unseen slaves working constantly for his comfort. One signals the furnace when the room temperature drops below normal. One keeps his running water just right for his bath. Another trips the switch to the compressor which refrigerates his food in the hottest summer. In scores of other ways, they provide the precise control of heat and cold which makes so many devices for modern living possible.
These noiseless, untiring slaves are Chace Thermostatic Bimetals. Rarely seen by the master, they are the actuating elements for temperature responsive devices. In the future, as in the past, the designer's ingenuity will be aided by the precision of the 35 Chace Bimetals, to bring forth more marvels for man's comfort.
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W.M. CHACE CO.
Manufacturers of
Thermostatic Bimetals
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mercury in the McLeod gage is available during equipment evacuation without using the mechanical forepump.

3. Since it is necessary to have no stopcocks on the high-vacuum side of a static system, some means must be provided for isolating the high-vacuum manifold from the condensation pumps. To obtain a positive shut-off the mercury cut-off illustrated in Fig. 141 is used. A barometric leg between the mercury reservoir and the cut-off is used and mercury return lines prevent mercury from surging into the manifold or condensation pumps. Vacuum for lowering the mercury is obtained from the same vacuum reservoir which supplied vacuum for the McLeod gage. The mercury cut-off in Fig. 139 is located behind the McLeod gage panel.

4. Condensation pumps. The condensation pumps in the system, Fig. 140, have been illustrated in Fig. 105 and 107. The up-jet pump is located on the high-vacuum side and the down-jet pump is located on the low-vacuum side. The latter pump is connected to a glass surge reservoir and the mechanical oil pump.

5. Heating Furnace. The furnace for heating glass equipment while it is being pumped is illustrated in Fig. 140. The furnace is built in sections which can be opened as illustrated. During the heating period the furnace is closed and a cover of Transite is placed over the top. When the equipment is tipped-off, the furnace can be opened as shown in the photograph. Equipment of various lengths can be pumped by using several furnace sections. The sections are set on a flat four-wheel cart. The temperature is controlled manually with the large Variac mounted on the wall to the left of the box rack.

6. Manometer and Electric Switch Panel. Three indicating U-tube manometers are located on the panel. The one on the left is connected to the high-vacuum side of the system. The middle manometer is connected to the vacuum reservoir used for lowering the mercury in the mercury cut-off and McLeod gage, while the manometer at the right is connected to the mechanical oil pump line. Three electric switches are used for the mechanical pump and the heaters of the two condensation pumps respectively.

7. Stopcocks. The stopcocks are all located on the mechanical pump side of the system. They are centrally located below the McLeod gage. Two three-way stopcocks are used for applying atmospheric pressure to the reservoir of the McLeod gage and the mercury cut-off. Two other stopcocks are used to close the forepump line to the condensation pumps and open this line to the auxiliary vacuum reservoir.

In concluding the description of this static vacuum system it should be pointed out that all manifolds are made of 25-mm. tubing. Liquid-nitrogen traps are located in the system to prevent migration of mercury vapor to the equipment being evacuated.

To be continued

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page 131.

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CONTROLLER

Cuts Panel Board Size to 1/3

ALL THESE ADVANTAGES

1. More Precise Control: Eliminates, or reduces to a negligible minimum, the time lag in the control circuit (point of measurement to controller and back to control valve) because Transet Controller can be at or very near the point of measurement.

This permits most favorable controller sensitivity and reset rate for process. For example, on one large installation the substitution of "Transet" permitted controller sensitivity to be raised from 5 to 50, and consequently much closer control resulted. Whereas with conventional remote pneumatic transmission system when controller-receiver is 300 to 1000 feet from transmitter, sufficient time lag in the control circuit [600 to 2000 feet] is introduced to require substantially unfavorable sensitivity and reset rate settings.

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6. More Convenient for Process Engineers: The easy-to-read dials on the compact panels enable the process engineer to easily and quickly check all related process variables without having to move all over a large control room.

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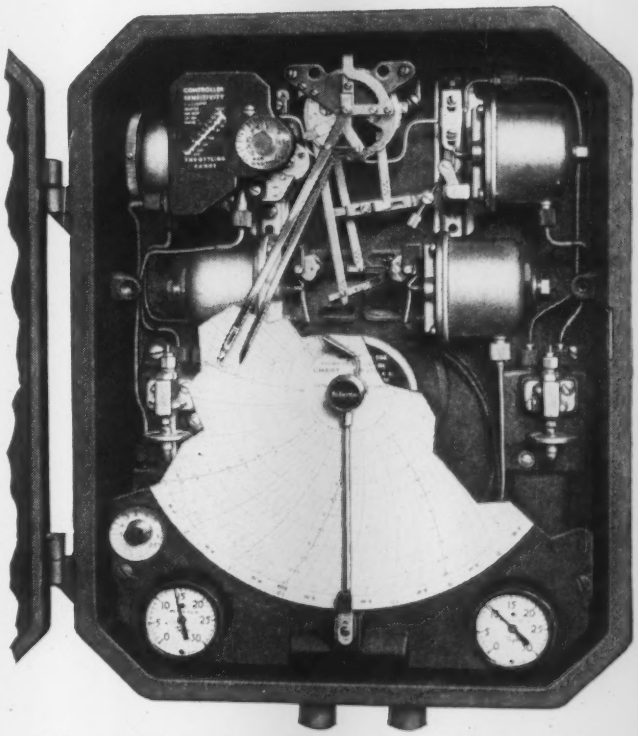
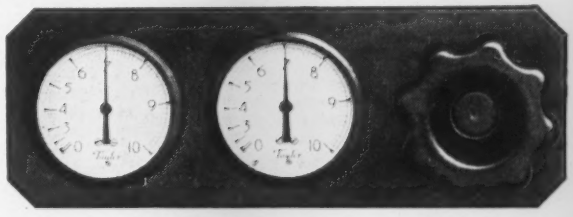


"TRANSET" Recording Controller-Transmitter.



Indicating Receiver (left). Set Pointer (center). Set Point Adjustment (right).

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The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. For further information use the postage-free Order Card on page 95.

Combustible Gas Indicator

New "Model L Combustible Gas Indicator" is intended primarily for use in the laboratory. Maker's previous portable "Model C" and "Model F" are dry-battery-operated; "Model L" operates on the ordinary 110-volt lighting circuit, thus always is ready for operation and saves expense and trouble of changing batteries. Other advantages include adaptability to introducing liquid traps, wash bottles, etc., into the sampling system, new feature of magnification of reading, and the vertical panel which lends itself to bench work. Among uses: Gas Analysis: Quickly testing gas samples for explosibility, as a check on field tests or as a part of laboratory analysis. Liquid testing: Navy Fuel Test (Navy Department Specifications 7-0-1g) and similar tests easily and quickly made on small samples. Results can be readily correlated with closed cup flash points, and are obtained more easily. Analytical work: In addition to direct testing of gas samples for presence of combustibles, "Model L" can

be used in any routine analytical method where a combustible gas is liberated under controlled conditions; e.g., hydrogen from acid or water by reaction of metals, dissolved hydrocarbons in liquid air, carbon monoxide from oxygen plus excess carbon, etc.—*Johnson-Williams, Ltd., Box 8, Palo Alto, Calif.*

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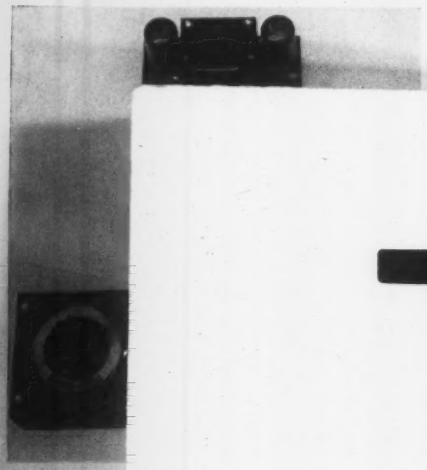
Remote-positioning Electrical Servo System

New "Synchro-Link" is a remote-positioning servo control which, it is said, will quickly and accurately position one or a number of distant electric motors according to the setting of the control transmitter. Accuracy is independent of load; it is better than 1% of full range. "Synchro-Link" is described as "an inexpensive packaged unit"; the same standard elements are adaptable, without modification, to an unlimited number of applications such as control of speed transmissions, valves, dampers, furnace doors, machine tools, etc. Two adjustments are provided: (a) A sensitivity control permits adjustment of accuracy or dead zone; i.e., allowable motion of the control shaft before correcting action of the motor is initiated; (b) An anti-hunting (anticipating) control for adapting characteristics of system to different values of



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Links" can be so connected that a single master control operates all slave units. Only three wires of light gage passing small control currents connect "Master Control" to "Synchro-Link Controller." Installation is said to be easy and inexpensive. New system operates on any 115-volt 60-cycle a-c. line.—*Yardeny Laboratories, Inc., 105 Chambers St., New York 7, N. Y.*

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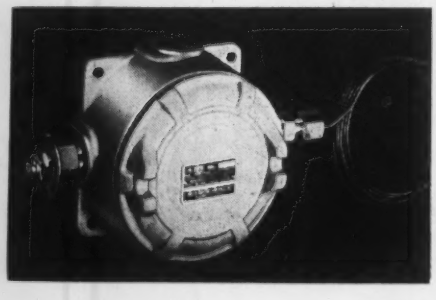

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applications where indicating and recording are not required, "Electromax" signals and controls only, although temperature readings can be taken manually with it at any time. Instrument consists of a Wheatstone bridge circuit with a vacuum-tube amplifier as the detector. Vacuum tubes are standard easily-purchased types, require no matching, balancing or other special selection. Instrument is completely a-c. operated—needs no dry batteries or standard cells. Lack of indicating or recording mechanism is said to make it a practically "zero maintenance" instrument. Temperature-sensitive elements used with "Electromax" are "Thermohms," L&N resistance thermometer bulbs. Length of leadwires does not affect calibration and location of "Thermohms" can be changed whenever desired. Instrument case is 11-9/16" × 11-1/16" × 9-1/16" and can be mounted wherever convenient. Standard ranges are 0 to 250°F. and 0 to 1000°F. or corresponding ranges of 0 to 150°C. and 0 to 550°C.—*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.*

Please mention number 104 when filling out card

Recording Rotameter

New type of recording rotameter utilizes Foxboro Co.'s "Dynalog" system of transmission by electronic high-frequency circuits

and recording system based on induction bridge system, together with rotameter flow-rate primary elements made by undersigned company. Features of new combination are said to be instantaneous response to change of flow, continuous balance, rugged power, continuous connections, unit construction using four principal assemblies, direct linkage with no gears, positive linear motion, long life and elimination of overtravel. Induction transmitter is available for recording rotor positions of many standard SK rotameter designs, including "Universal Rotameter," "Armored Rotameter" and others.—*Schutte & Koerting Co., 12th and Thompson Streets, Philadelphia 22, Pa.*

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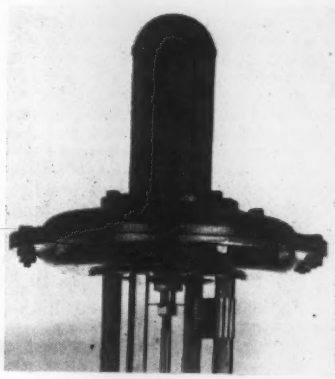

Resonance-type Thickness Gage

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two adjacent audible signals as read on tuning dial is readily converted into wall thickness on a concentric thickness scale. "Audigage" provides other information than thickness alone: character of audible indications varies with kind of material, condition of reflecting surface, back-up liquids, process scale, etc. These factors provide useful information but do not influence accuracy of thickness measurement. "Audigage" can be applied to steel, aluminum, brass, copper, glass, and other materials; covers a range of ⅛" to 12".—*Branson Instruments, Inc., Joe's Hill Road, Danbury, Conn.*

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Diaphragm-motor Valve for Chemical Service

New "Valvrator" is said to represent a "totally new design in diaphragm-motor valve construction." Among design features said to be unique is dished-bonnet construction with flush-seated bodies and through-bolts. No bonnet flanges are included in body construction and design is said to result in a compact unit with lowest possible weight, greatly simplified clean-out characteristics and possibility for fabrication in nearly all corrosion-resisting materials. Body materials such as iron, bronze,

Predetermined Electronic Counter

New "Model 140" Single Channel Predetermined Counter will count and control at rates of 15,000 per minute and higher if required. It has been designed to meet requirements of manufacturers concerned with high-speed counting, batching and packaging of processed items such as sheet metals, pills, buttons, hardware, cartons, etc. Desired count is initially set by means of dial switches located on front panel. When predetermined number of items has been counted, unit actuates a control which is used to automatically stop or divert the flow of materials. Counter can be set to recycle automatically, or manually by means of a remote-control switch. When automatic reset is used, instrument will reset in 2 milliseconds. Unit utilizes four of maker's standard 4-tube counter decades which are arranged to permit the use of any predetermined number from 0 to 10,000. Other models are available which provide two separate predetermined channels for control of two-step sequential processes, such as in manufacture of zipper fasteners. Input to counter can be derived from interruption of a photoelectric beam, contact closures, shaft rotation, reciprocating members, electromagnetic field disturbance, etc. Output consists of an ultra-high speed double-pole single-throw relay which is readily adaptable to solenoid actuation of existing controls. Variations of these counters for special application are also available.—*Potter Instrument Co., 136-56 Roosevelt Avenue, Flushing, N. Y.*

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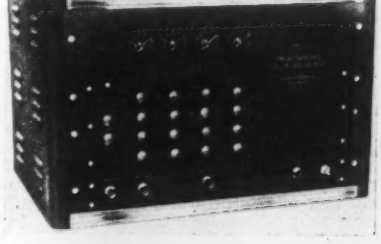
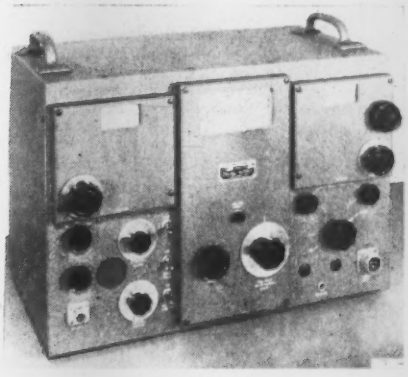


Radio Field Intensity Meter

New "Model 106 VHF Field Intensity ter" for use in the television and FM nds from 50 to 220 Mc. is direct-reading terms of microvolts per meter (without e of charts, curves or calculations) over range of 5 microvolts to 10 volts. Rever employs a stage of amplification at nal frequency and features single-control ning with provisions for separate fine justment of antenna and mixer input ning controls without disturbing gang ning. A built-in calibrating oscillator proles a source of standard signal for calibating instrument. A circuit arrangement ovides what is essentially an "electrical



slide rule" which preserves direct-reading feature even though equipment is used with an antenna other than standard dipole which is basis for calibration. A vibrator power supply is incorporated and provision made for substitution of a 110-volt power supply where measurements or recordings are required over an extended period at a fixed location. Selectivity of new instrument is adequate for measurements on adjacent channels 200 kc. apart, a feature particularly necessary for interference studies in the FM band. Specially designed i-f. transformers provide for varying selectivity from a flat-top response with 200-kc. band width and exceptionally sharp cut-off to a highly selective condition when coupling is made slightly less than critical. Weight of instrument with power supply is 40 lbs.—*Clarke Instrument Corp., 910 King St., Silver Spring, Md.*

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Vacuum Leak Detector

New "Model 24-101" portable leak detector can locate and measure leaks in vacuum and pressure systems as minute as 0.00000001 cc. per second. Based on the mass spectrometer principle, instrument separates and measures helium molecules, by reason of their mass, from other molecules in the atmosphere. Therefore, to use instrument, helium is introduced in suspected

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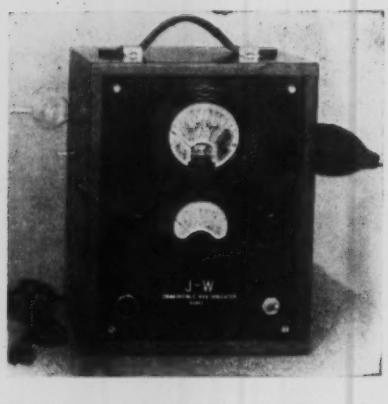

be used in any routine analytical method where a combustible gas is liberated under controlled conditions; e.g., hydrogen from acid or water by reaction of metals, dissolved hydrocarbons in liquid air, carbon monoxide from oxygen plus excess carbon, etc.—*Johnson-Williams, Ltd., Box 8, Palo Alto, Calif.*

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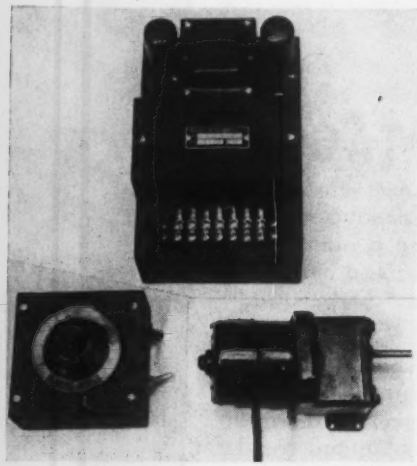
Remote-positioning Electrical Servo System

New "Synchro-Link" is a remote-positioning servo control which, it is said, will quickly and accurately position one or a number of distant electric motors according to the setting of the control transmitter. Accuracy is independent of load; it is better than 1% of full range. "Synchro-Link" is described as "an inexpensive packaged unit"; the same standard elements are adaptable, without modification, to an unlimited number of applications such as control of speed transmissions, valves, dampers, furnace doors, machine tools, etc. Two adjustments are provided: (a) A sensitivity control permits adjustment of accuracy or dead zone; i.e., allowable motion of the control shaft before correcting action of the motor is initiated; (b) An anti-hunting (anticipating) control for adapting characteristics of system to different values of



inertia of motors and loads in various applications. Once set, these controls do not require any attention or adjustment. Description.—"Synchro-Link" works on the principle of a self-balancing electronic bridge. It consists of three basic elements: (1) "Master Control" with a knob and a calibrated dial for manual control or with ¼" shaft extension for automatic control; (2) "Synchro-Link Electronic Controller"; (3) "Load Control Potentiometer" geared to the motor or coupled to the load. Motor is not supplied as part of "Synchro-Link" but any reversible motor can be used, so that user has complete freedom in choice of a motor most suitable for application. Rating.—"Synchro-Link Controller" contacts will handle 15 amps., 110-volt a.c. or 10 amps., 220-volt a.c. Motors up to 1/10 hp. can be connected directly; motors from 1/10 to 35 hp. use standard magnetic reversing starter. All elements are standardized and interchangeable. Several "Synchro-Links" can be so connected that a single master control operates all slave units. Only three wires of light gage passing small control currents connect "Master Control" to "Synchro-Link Controller." Installation is said to be easy and inexpensive. New system operates on any 115-volt 60-cycle a-c. line.—*Yardeny Laboratories, Inc., 105 Chambers St., New York 7, N. Y.*

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Explosion-proof Thermostat

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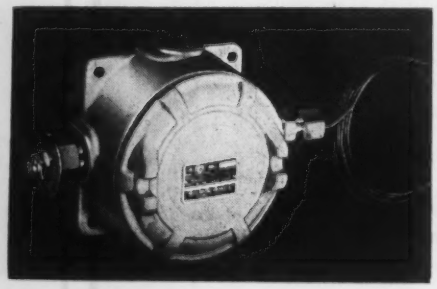

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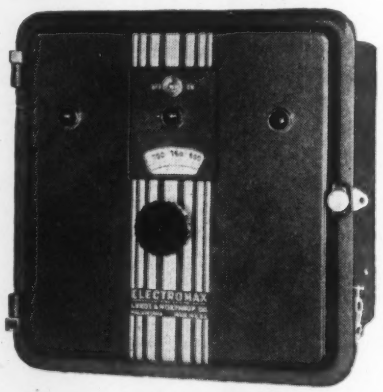
Automatic Temperature Controller

New "Electromax," for control of ovens, stills, baths, presses and coolants, is said to fill long-felt need for an inexpensive temperature controller which has high sensitivity and versatility and needs practically no attention. Especially designed for those



applications where indicating and recording are not required, "Electromax" signals and controls only, although temperature readings can be taken manually with it at any time. Instrument consists of a Wheatstone bridge circuit with a vacuum-tube amplifier as the detector. Vacuum tubes are standard easily-purchased types, require no matching, balancing or other special selection. Instrument is completely a-c. operated—needs no dry batteries or standard cells. Lack of indicating or recording mechanism is said to make it a practically "zero maintenance" instrument. Temperature-sensitive elements used with "Electromax" are "Thermohms," L&N resistance thermometer bulbs. Length of leadwires does not affect calibration and location of "Thermohms" can be changed whenever desired. Instrument case is 11-9/16" × 11-1/16" × 9-1/16" and can be mounted wherever convenient. Standard ranges are 0 to 250°F. and 0 to 1000°F. or corresponding ranges of 0 to 150°C. and O to 550°C.—*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.*

Please mention number 104 when filling out card

Recording Rotameter

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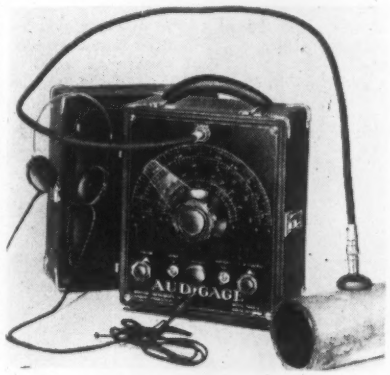
and recording system based on induction bridge system, together with rotameter flow-rate primary elements made by undersigned company. Features of new combination are said to be instantaneous response to change of flow, continuous balance, rugged power, continuous connections, unit construction using four principal assemblies, direct linkage with no gears, positive linear motion, long life and elimination of overtravel. Induction transmitter is available for recording rotor positions of many standard SK rotameter designs, including "Universal Rotameter," "Armored Rotameter" and others.—*Schutte & Koerting Co., 12th and Thompson Streets, Philadelphia 22, Pa.*

Please mention number 105 when filling out card

Resonance-type Thickness Gage

New "Model FMSS-4 Audigage" is a portable self-contained (battery-operated) instrument designed to measure the thickness of many materials, including steel, from one side only, hence especially useful for thickness determination of pipes, storage tanks, pressure vessels, ship hulls, etc. Operating principle is non-destructive: "Audigage" utilizes a crystal-type gage head powered by a frequency-modulated electronic oscillator. When vibrating crystal is applied to a wall surface, wall section resonates mechanically below crystal, at a fundamental frequency directly proportional to velocity of sound in material and inversely proportional to wall thickness. Wall section will also resonate at all harmonics of fundamental frequency. "Audigage" provides a means whereby audible signals are

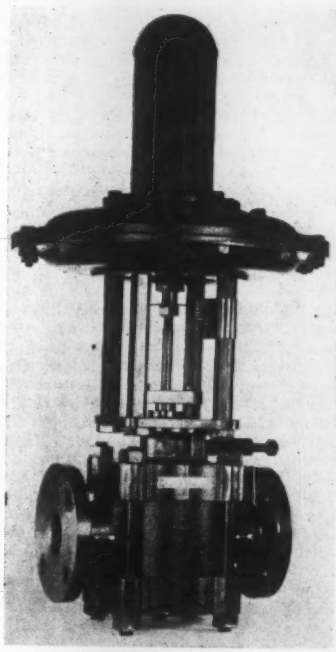


produced corresponding to harmonic resonance. Frequency difference between any two adjacent audible signals as read on tuning dial is readily converted into wall thickness on a concentric thickness scale. "Audigage" provides other information than thickness alone: character of audible indications varies with kind of material, condition of reflecting surface, back-up liquids, process scale, etc. These factors provide useful information but do not influence accuracy of thickness measurement. "Audigage" can be applied to steel, aluminum, brass, copper, glass, and other materials; covers a range of ⅛" to 12".—*Branson Instruments, Inc., Joe's Hill Road, Danbury, Conn.*

Please mention number 106 when filling out card

Diaphragm-motor Valve for Chemical Service

New "Valvrator" is said to represent a "totally new design in diaphragm-motor valve construction." Among design features said to be unique is dished-bonnet construction with flush-seated bodies and through-bolts. No bonnet flanges are included in body construction and design is said to result in a compact unit with lowest possible weight, greatly simplified clean-out characteristics and possibility for fabrication in nearly all corrosion-resisting materials. Body materials such as iron, bronze,



stainless steel, carbon steel, hard lead, Haveg, hard rubber, Monel, nickel, Hastelloy and even porcelain are regularly available. New valve is made only in 150-lb. construction in sizes from ¼" to 1" screwed, and from 1" to 3" flanged.—*Dep't 5C, Fischer & Porter Co., Hatboro, Penna.*

Please mention number 107 when filling out card

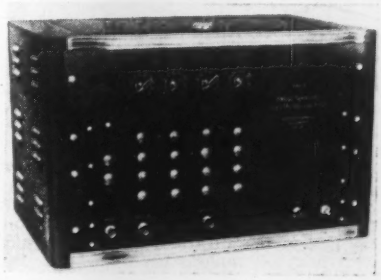
Consistency Controller

New consistency regulator is announced by undersigned company which announced at the same time the purchase of the consistency control patents from the Cram Company of Appleton, Wis. Combining operating principles covered by the former Cram patents with Askania's own hydraulic control system, new regulator is claimed to represent an extremely accurate and positive method for the control of thin-stock consistency (as low as 0.1%) as required by the pulp and paper industry.—*Askania Regulator Co., 1603 South Michigan Ave., Chicago 16, Illinois.*

Please mention number 108 when filling out card

Predetermined Electronic Counter

New "Model 140" Single Channel Predetermined Counter will count and control at rates of 15,000 per minute and higher if required. It has been designed to meet requirements of manufacturers concerned with high-speed counting, batching and packaging of processed items such as sheet metals, pills, buttons, hardware, cartons, etc. Desired count is initially set by means of dial switches located on front panel. When predetermined number of items has been counted, unit actuates a control which is used to automatically stop or divert the flow of materials. Counter can be set to recycle automatically, or manually by means of a

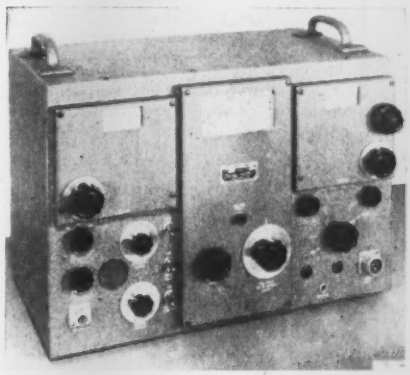


remote-control switch. When automatic reset is used, instrument will reset in 2 milliseconds. Unit utilizes four of maker's standard 4-tube counter decades which are arranged to permit the use of any predetermined number from 0 to 10,000. Other models are available which provide two separate predetermined channels for control of two-step sequential processes, such as in manufacture of zipper fasteners. Input to counter can be derived from interruption of a photoelectric beam, contact closures, shaft rotation, reciprocating members, electromagnetic field disturbance, etc. Output consists of an ultra-high speed double-pole single-throw relay which is readily adaptable to solenoid actuation of existing controls. Variations of these counters for special application are also available.—*Potter Instrument Co., 136-56 Roosevelt Avenue, Flushing, N. Y.*

Please mention number 109 when filling out card

Radio Field Intensity Meter

New "Model 106 VHF Field Intensity Meter" for use in the television and FM bands from 50 to 220 Mc. is direct-reading in terms of microvolts per meter (without use of charts, curves or calculations) over a range of 5 microvolts to 10 volts. Receiver employs a stage of amplification at signal frequency and features single-control tuning with provisions for separate fine adjustment of antenna and mixer input tuning controls without disturbing gang tuning. A built-in calibrating oscillator provides a source of standard signal for calibrating instrument. A circuit arrangement provides what is essentially an "electrical

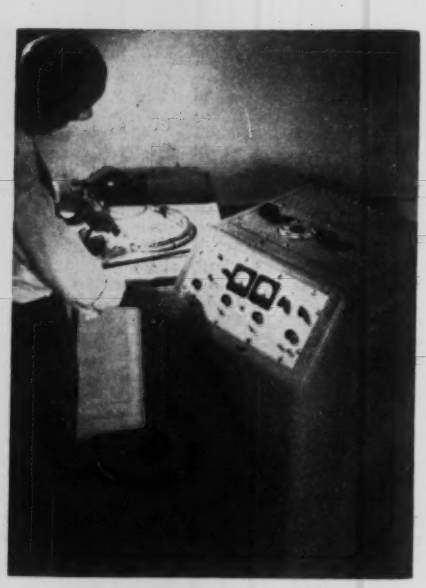


slide rule" which preserves direct-reading feature even though equipment is used with an antenna other than standard dipole which is basis for calibration. A vibrator power supply is incorporated and provision made for substitution of a 110-volt power supply where measurements or recordings are required over an extended period at a fixed location. Selectivity of new instrument is adequate for measurements on adjacent channels 200 kc. apart, a feature particularly necessary for interference studies in the FM band. Specially designed i-f. transformers provide for varying selectivity from a flat-top response with 200-kc. band width and exceptionally sharp cut-off to a highly selective condition when coupling is made slightly less than critical. Weight of instrument with power supply is 40 lbs.—*Clarke Instrument Corp., 910 King St., Silver Spring, Md.*

Please mention number 110 when filling out card

Vacuum Leak Detector

New "Model 24-101" portable leak detector can locate and measure leaks in vacuum and pressure systems as minute as 0.00000001 cc. per second. Based on the mass spectrometer principle, instrument separates and measures helium molecules, by reason of their mass, from other molecules in the atmosphere. Therefore, to use instrument, helium is introduced in suspected



areas and an almost immediate indication is given on visual or audio alarm system whenever any leakage is present. An inexperienced person can operate new leak detector since only a few connections place instrument in vacuum system and a few adjustments prepare it for use. Selection of sensitivity over six ranges can be had for measuring almost any rate of leakage. Size of leak can also be determined with audio system when using a helium probe at a distance from instrument: pitch of leakage warning signal changes roughly in proportion to the leak size. Instrument is portable, being installed in a cabinet 43" high, 25" deep and 22" wide and mounted on ball-bearing rubber-tired casters. Electrical chassis mounted on back of door which has a removable panel to permit entrance to wiring of chassis. Standard readily-available electrical and vacuum components are used. Equipment operates from 115-volt 60-cycle lighting circuit.—*Consolidated Engineering Corp., Dept. BG, 620 N. Lake Ave., Pasadena 4, Calif.*

Please mention number 111 when filling out card

VHF Circuit Tester

New "Model WV-75A VoltOhmyst" for servicing industrial and radio equipment using VHF (up to 250 Mc.) employs a newly-developed diode probe and incorporates

same refinements as low-frequency "Type 195A." It comprises a VHF voltmeter, audio voltmeter, a-c. voltmeter, d-c. voltmeter, ohmmeter, and FM indicator. Features are ability to read both a-c. and d-c. voltages up to 1000 volts and a monitoring circuit said to make instrument virtually burn-out proof. Diode probe contains a standard AN integral female fitting for direct connection to a coaxial line. Measurements at high frequencies are made by direct contact with central pin and ground ring at end of diode probe, while an alligator clip for central pin and short ground lead serve as adaptors for voltage measurements at lower frequencies. Case weighs 9 lbs., measures 9⅝" high, 6⅜" wide and 6¾" deep.—*Test & Measuring Equip't Sec., RCA Engineering Products Dep't, RCA Victor Div., Camden, N. J.*

Please mention number 112 when filling out card

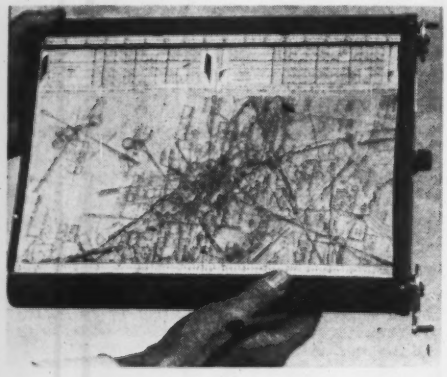
Rotary Counter

New "Model Y" is a small high-speed light-operating end-drive rotary counter easily adaptable as an integral part of office machinery, laboratory equipment, and high-speed, light-duty production machinery. Case is 1.777" to 3.056" long by 1.238" high by 1.202" wide; capacity 999 to 99,999,999. Figures are 0.180" × 0.0999", black on white background, or white on black background. Ratio 10:1 or 1:1 as specified; speed up to 2000 rpm. Unit is finished in durable black wrinkle enamel.—*Durant Mfg. Co., 1914 N. Buffum St., Milwaukee 1, Wis.*

Please mention number 113 when filling out card

Map Case for Cross-country Flying

New "Rolaire Map Case," as name suggests, is for easy handling, in flight, of air maps made in a continuous roll. As he flies cross-country, pilot can slowly unroll the map of his entire route with a single turn of the knob. Case measures 12½" × 10" × 1½", weighs 37 ounces, and takes 22 feet of any kind of air maps. Plastic face of map case is specially treated for pencil notations. A rheostat-controlled internal light for night flying is optional. Maps are easily loaded or unloaded. Forty-one standard map rolls are already available for most routes and large areas. A "Navtab" at the end of each route shows distances and magnetic courses for each leg between principal cities and airports, already computed and ready

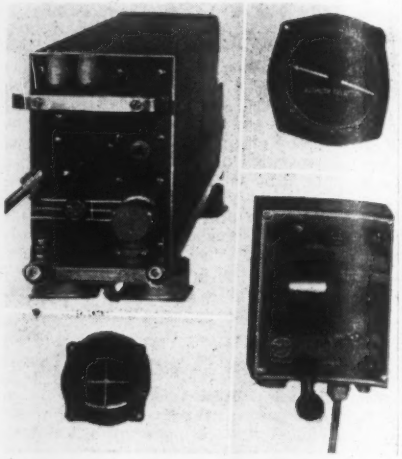


to fly. This saves hours of plotting. One roll will hold 4000 miles of regional or route charts; 2000 miles of sectional maps; 8000 miles of direction finding charts; or any combination of these maps plus a section of planning chart.—*Rolaire Engineering Products, Los Angeles 5, Calif.*

Please mention number 114 when filling out card

Navigation and Communication VHF Receiver for Airlines

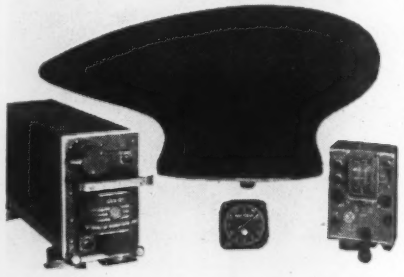
New "Type AVR-25" aircraft navigation and communication VHF receiver consists of four separate units to simplify installation. Pictured at left is receiver unit which operates on all aircraft VHF channels (108 to 132 Mc.) and makes possible the use of two-course visual ranges as well as omnidirectional ranges, without additional equipment or modification. At right is pilot's control box for remote tuning and switching. Navigation with this receiver is simplified to such an extent, that pilot has only to determine his flight course, set the azimuth selector (upper right) to desired compass reading, and pilot the plane so that the "left-right" hairline indicator in the localizer (lower left) is kept in the center position, in order to keep his plane on course.—*Aviation Section, Engineering Products Dep't, Radio Corp. of America, Camden, N. J.*



Please mention number 115 when filling out card

Fully-automatic Direction Finder

New "Model AVR-21" is a completely automatic direction finder and receiver consisting of four components. Receiver (left) one-half standard ATR rack size, which can be mounted in any convenient space; pilot's



remote control box mounted on plane's instrument panel; Azimuth Indicator Unit which can also be mounted on instrument panel; and streamlined enclosed loop antenna which mounts either on top or bottom of fuselage. Receiver has a self-contained vibrator power supply which operates from either a 12- or 24-volt primary source. Vibrator supply is lightly loaded to insure long service and may be switched easily for operation with a 12- or 24-volt supply with no new components required. Although unit is designed for standard ATR mounting, a special 10-G shock mount is also available. All band and function switching on receiver is accomplished by one gang switch driven by a ratchet motor. Only one switch shaft is used. Control for motor is located on pilot's control unit. Streamlined loop antenna housing is of single unit construction, sealed against dust and moisture, and suitable for use on aircraft with pressurized cabins. It is chemically coated to provide static drain. This coating, together with loop shield, serve to reduce precipitation static interference. Pilot's control box is a standard RCA aircraft equipment unit containing all necessary controls, which are grouped for ease of operation. It provides a calibration scale of 9½" on each of the three bands. Band change switch and indicator are interlocked with tuning dial and provide unmistakable indication of the band in use. A built-in dimmer controls intensity of dial light. A position is provided on unit

to switch to manual-electrical operation for aural-null direction finding. By moving this switch to right or left, pilot rotates antenna loop electrically to obtain a line of position from a given radio station. Azimuth indicator conforms to standard dimensions and is mechanically interchangeable with existing units. Electrical design permits use of additional units for remote operation if required. A dual pointed indicator is available for dual ADF operation.—*Aviation Section, Engineering Products Dep't, Radio Corp. of America, Camden, N. J.*

Please mention number 116 when filling out card

Electrical Automatic-pilot System for Aircraft

New "Model L-201 Electropilot" is intended for automatic control of attitude of aircraft in flight. With additional accessories, it can be used for automatic take-off and landing. Claimed advantages are extreme light weight, small components, simple installation, quick calibration, simple reliable operation and (being all-electric) ready adaptability to such developments as automatic approach, automatic landing and take-off, and automatic altitude control. Weight is about 39 lbs., and for airplanes already having directional gyro and artificial horizon instruments weight is 29 lbs. (See complete table herewith.) "Electropilot" consists of the following principal units: (1) Controller (Fig. 1). This unit has an OFF, READY and ENGAGE switch, a TURN control knob, a ROLL trim, and an elevator or PITCH control knob. Electrical interlock prevents engaging Electropilot before sufficient time has elapsed to allow apparatus to become operative, and also protects against engaging Electropilot if the gyros are not properly uncaged. (2) "Magnaslave Compass" comprises a magnetic sensing element located in wing tip which automatically and continuously corrects the directional gyro to the proper magnetic heading. (3) Triple Servo unit (Fig. 2) is an electromagnetic power unit for operating rudder, elevator, and aileron cables. It can be mounted at any convenient place in airplane, and is controlled by the directional gyro and the gyro horizon through amplifier unit. (4) Automatic Trim Tab servo automatically keeps airplane in proper pitch trim at all times, with varying load conditions. (5) Amplifier (Fig. 3) is the "brain" of the Electropilot: it takes the signals it receives from the gyros and

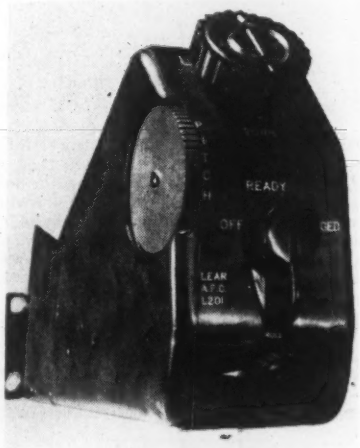


Fig. 1

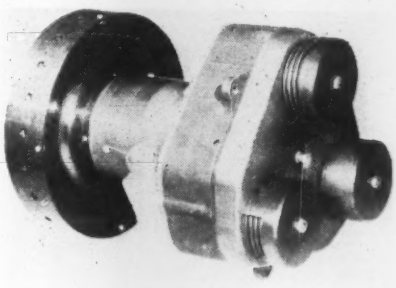


Fig. 2

properly interprets them, and supplies power to the servos in direct proportion and phase relationship, to accomplish stabilized flight. (6) Synchrometer is an instrument for synchronizing directional gyro to original magnetic heading: adjustment only has to be made once for every flight, as thereafter "Magnaslave" unit is entirely automatic. Synchrometer also supplies information regarding control surface trim of the airplane. It tells the pilot at a glance in which direction and how much trim should be applied to rudder and aileron. Pitch trim is automatic. (7) A horizontal gyro and (8) a slaved directional gyro transmit signals of attitude of airplane through electrical pickoffs. "Electropilot" utilizes the gyros already installed in the airplane, or the gyros may be mounted within the amplifier. Power Requirements: "Electropilot" operates from standard 24-28 volt aircraft battery. An inverter on Triple Servo supplies single-phase 500-cycle a.c. at 31 volts, and two-phase 500-cycle a.c. at 28.5 volts. Current consumption in amperes at 24 volts, is as follows:

	Stand-by	*Operating*	*Rough Air*
Amplifier	3.0	3.0	3.0
Triple Servo	4.5	6.5	7.5
Trim Tab Servo	—	0.5	0.5
Totals	7.5	10.0	11.0

Operational Characteristics: New "Electropilot" provides for turns up to 30° in bank in either direction, and provides for climb

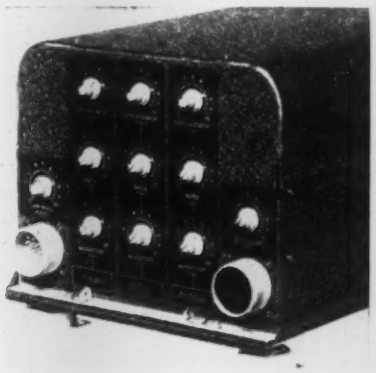


Fig. 3

or dive angles ±25°. New "Electropilot" does not use any direct mechanical or electrical follow-up system: it works on the displacement and rate-of-displacement principle without use of rate gyros. Rate signals are derived from discriminator and amplifier circuits which advance the phase of the gyro signals in some cases as much as 140°. "Electropilot" will stabilize the airplane through a wide range of air speeds, from stalling speed to maximum speed of aircraft without re-adjustment. It is fully synchronized in pitch and yaw, and is designed always to level airplane in roll whenever it is engaged. It may be over-controlled by the pilot when it is operating. —*Lear, Inc., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.*

Please mention number 117 when filling out card

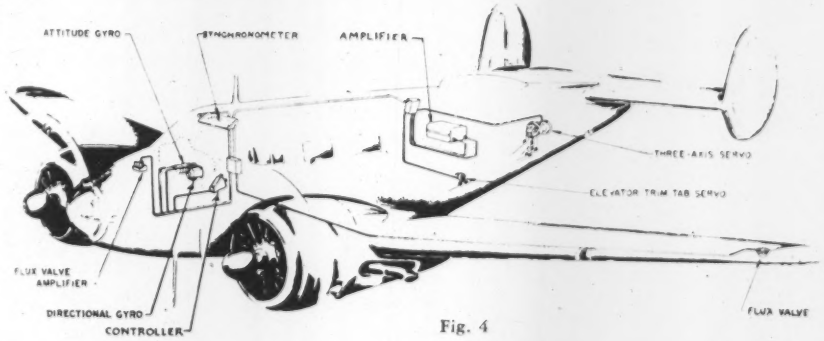


Fig. 4

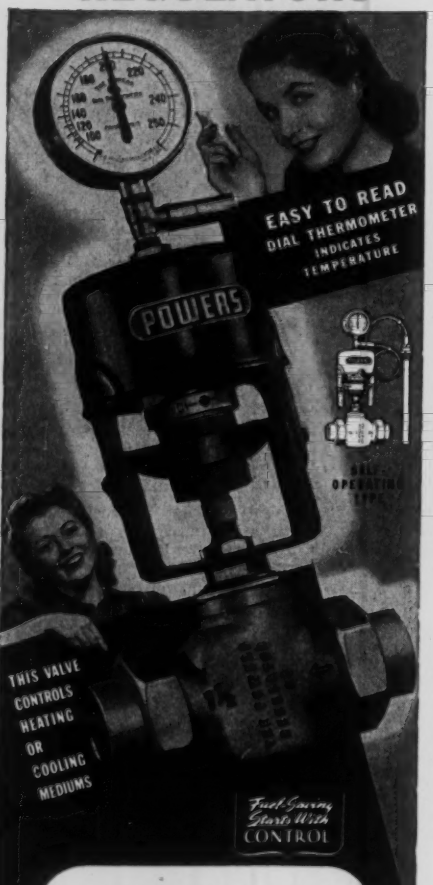
Unit	Height	Width	Depth	Dia.	Weight
Controller	5 7/16"	2 3/4"	7 1/8"	....	1.93 lbs.
Magnaslave Compass:					
Valve	3 3/16"	....	....	4 25/32"	1.25
Amplifier	5 1/4"	4 3/4"	4 3/8"	....	1.33
Directional Gyro	7 9/16"	....	....	4 5/8"	4.50
Horizontal Gyro	6 9/16"	4 9/16"	6 1/16"	....	3.19
Amplifier, less shock mount	6 3/4"	8 5/8"	13"	....	9.875
Triple Servo, 115D	10 3/16"	....	....	7 1/2"	13.90
Trim Tab Servo, 119F	5 5/8"	3 15/32"	5 17/32"	....	2.20
Synchrometer	....	....	3 1/2"	3 1/4"	0.875
					39.05 lbs.

Aircraft Communication and ADF Receiver

New "AVR-22" is a general-purpose aircraft communication receiver which may also be used as a radio direction finder, is one-half standard ATR rack size and is designed for remote installation on aircraft. It covers complete frequency range from weather reports and range beacons through standard broadcast band and airline channels. These bands are available instantly by means of a selector switch. Airline band is provided with continuous tuning in the range of 2830 kc. to 8050, and four crystal-controlled spot frequencies in the range of 2830 to 13,000 kc. A "quick-shift" position is also provided for the 278-kc. traffic control range. Direction finding and homing is made possible by addition of loop antenna. A CW beat-frequency oscillator is included in the circuit to aid in location of weak stations. Either conventional loop or wire antenna operation may be selected at will in the 150- to 420-kc. and 545- to 1625-kc. frequencies. In the 2830- to 13,000-kc. range, wire antenna operation alone is possible. "AVR-22" comprises two main units—remote control box which can easily be mounted on front instrument panel, and the self-contained receiver which can be located in any convenient space in aircraft. Remote

Economize WITH POWERS

TEMPERATURE REGULATORS



Use a Powers No. 11 Temperature Indicating Regulator when you want the advantages of an easy-to-read dial thermometer combined with a dependable self-operating regulator. The dial thermometer gives a visual check on the performance of the regulator and makes it easy to adjust for the required operating temperature. Various dials and ranges are available.

Is Easy To Install—because both the thermometer and the regulator operate from the same thermal system—only one tapped opening is required.

Write for Circular 2511

THE POWERS REGULATOR CO.

2734 Greenview Avenue, Chicago 14, Illinois
231 E. 46th St., New York 17, N. Y.—Offices in 47 Cities . . . See your phone directory.

70

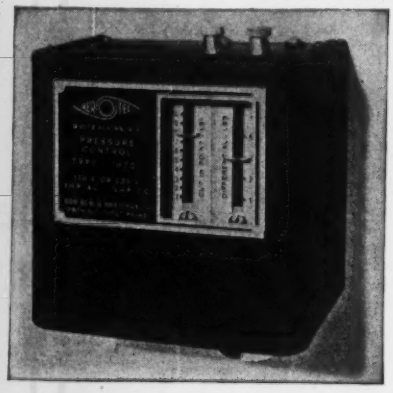
OVER 50 YEARS
OF AUTOMATIC TEMPERATURE AND HUMIDITY CONTROL

operation of "AVR-22" is accomplished electrically with receiver control box which selects bands and spot frequencies by means of a ratchet motor operating a single switch gang. All other functions are electrically selected. Manual tuning is accomplished by a new type control head with a 9½" continuous drum type dial. Receiver contains its own built-in dynamotor power supply, which connects with a 14- or 28-volt power supply. It weighs 21 lbs., is approx. 14" long, 4" wide, and 9" high. "AVR-22" is planned for systems operation and is adequately shielded to function satisfactorily without interaction with other equipments. It is designed and manufactured to airline standards and fulfills all requirements for CAA type certification.—*Aviation Section, Engineering Products Dep't, Radio Corp. of America, Camden, N. J.*

Please mention number 118 when filling out card

Pressure Switches

New line of "Aerotec" pressure switches for control of automatic gas, oil or coal fired steam boilers, is also available for use on air and refrigeration compressors and



pumps. Pressure range on "H-701" is from 1 to 10 lbs./in.² with a differential of 1 to 5 lbs./in.². Also available are ranges up to 300 lbs. and differentials of 1 to 80 lbs., with Micro-Switch contact arrangements of normally-off and normally-on. "H-700" will handle any liquid or gas not injurious to brass. Unit is easily set by finger-tip adjustments from outside cover. Scales for range and differential are easily read through a window in cover.—*Thermix Corp., Greenwich, Conn.*

Please mention number 119 when filling out card

92%-efficiency Air Filter for Pneumatic Instruments

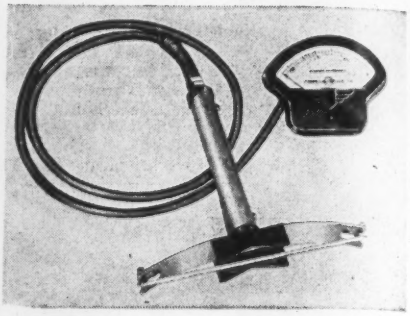
New air filter dripwell is primarily designed to remove oil fog from instrument supply air. Manufacturer reports results of an efficiency test of new filter and of five conventional instrument - type filters: All six filters were saturated, blown down, then supplied with air at a flow of 0.25 s.c.f.m. in which a known quantity of oil had been vaporized. Test on each filter was run for 100 hours without draining, and trapped liquid was weighed. New air filter trapped 92% of entrained oil while conventional filters retained 9% to 59%. Pressure drop through new air filter, with a supply pressure of 75 lbs./in.² a flow of 0.

s.c.f.m., is approximately ⅛ lbs./in.². Filtering material is contained in an open-end brass cylinder mounted in a brass housing. Air enters top of inner cylinder, passes down through filtering material and up between cylinder and housing. Trapped oil and moisture are retained in a bottom chamber until blown off. A continual cleaning of the filtering material results from steady "blow-down" action of the air. Unit is brass and bronze construction, 2⅛" in diameter by 9" long, with ¼" pipe connections.—*Moore Products Co., H & Lycoming Sts., Philadelphia 24, Pa.*

Please mention number 120 when filling out card

Roll Surface Pyrometer

New "RollTemp" is essentially a surface pyrometer with indicating instrument separated from thermocouple. Instrument proper is mounted permanently and conveniently on machine requiring tests: operator need

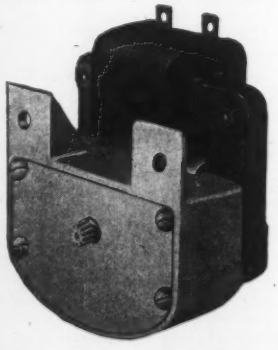


handle only the ruggedly-constructed thermocouple assembly. This method of handling permits the layman to make temperature measurement without previous knowledge of instrument care and handling. Since diameter of heated surface determines size of thermocouple spacing plate, when ordering it is necessary to include approximate diameter of hot surface. "RollTemp" is suited for use in plastic, rubber, and metal industries as well as for laundries, etc., and wherever a roll or tube requires temperature reading. — *Pyrometer Service Co., 230 River Road, North Arlington, N. J.*

Please mention number 121 when filling out card

Timing Motors

New models of self-starting small synchronous motors require an input of 1½ watts and produce a starting and synchronous running torque of 10 inch-ounces at



1 rpm. This increase in torque has been accomplished without a corresponding increase in iron and copper weight. Gears being enclosed in a die-casting which supports bearings and seals in lubricant, no re-oiling is required. Standard motor illustrated is designed to operate on 100-125V, 60 cycles, and has a load shaft speed of 4 rpm. Pinion normally provided on this shaft has 10 teeth, 64 pitch, 5/32" pitch diameter. Lower speeds are readily obtained

by adding a gear sub-assembly of proper ratio. New motors can be furnished for voltage from 1 to 250 and frequencies from 25 to 120. Overall size: 2" × 2⅜" × 1¼"; weight, approx. 9 oz.—*Kurman Electronics Corp., 130 Clinton Street, Brooklyn, N. Y.*

Please mention number 122 when filling out card

Instrument Timing Motor

New "Model SX" is said to meet need for a powerful, small, precision-built, self-starting synchronous motor of high operating efficiency. It measures 2⅝" × 2⅛" × 1½", yet its torque is 30 inch-ounces at 1 r.p.m. Power input is 2.7 watts at 115 or 230 volts, 60 cycles. Average heat rise is 30°C. at rated voltage. Rotor speed is 240 r.p.m. at 60 cycles. There are 28 interchangeable standard gear trains for speeds from 60 r.p.m. to one revolution in 24 hours. Lubricant sealed within gear housing is said to provide adequate lubrication for many years of service. Coils are easily removable, thereby facilitating changes in voltage rating or in field servicing. "SX Motor" is said to be particularly suited for timing devices, recording instruments, communications equipment, traffic controls, heating controls and signaling systems.—*R. W. Cramer Co., Centerbrook, Conn.*

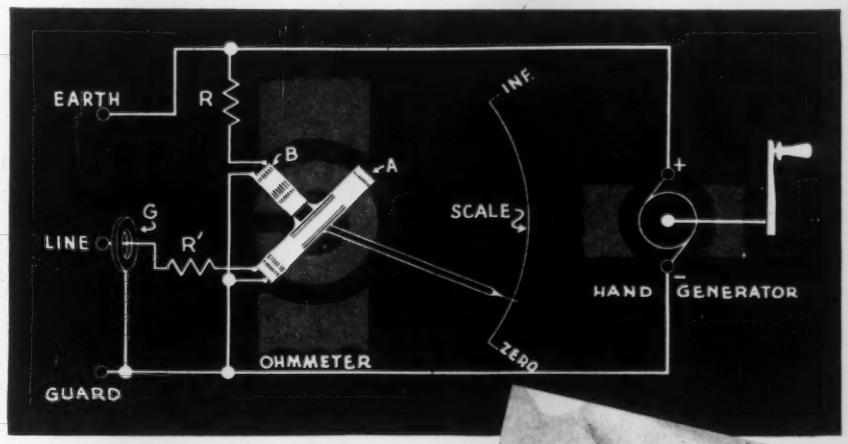
Please mention number 123 when filling out card

Modulation Meter

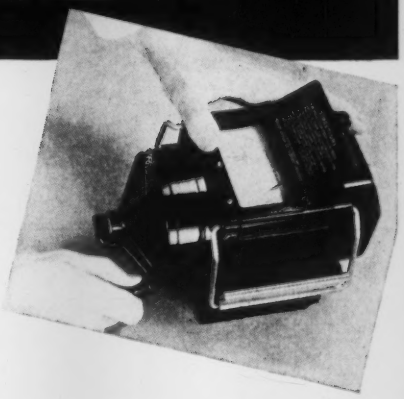
New "Type X-7018 Modulation Meter" operates without vacuum tubes and requires neither batteries nor a-c. line power; is designed primarily for use in the amateur phone bands falling between 3.5 and 54 Mc. but is also useful for other services,

Here's why—

"MEGGER"* Insulation Testers are always dependable—



In what we term a cross-coil true ohmmeter, two coils are mounted in fixed relation to each other on the same pivot-and-jewel moving system in the field of a permanent magnet. "Current" flows in coil A and "potential" in coil B, and they are connected so that their respective torques oppose each other. Since there are no control springs, the opposing coils give a true ratio of E/I, and ohms (or megohms) are indicated by a pointer over a scale. The readings are independent of the voltage of the hand-driven d-c generator, because any change in the voltage affects both coils in the same proportion.



The "Megger" instrument is simplicity itself. The circuit diagram shows *all* elements—hand-cranked generator, fixed resistance coils and ohmmeter with pointer and scale. Nothing more is needed and nothing could be simpler. In making resistance tests, you merely connect leads from the instrument to the apparatus or circuit under test, turn the crank for a few seconds, and read the insulation resistance directly on the scale.

Power generation and distribution practice has dictated certain standards of quality and performance that every piece of electrical equipment is expected to meet. "Megger" insulation testing instruments have been and will continue to be built in conformity with these high standards.

For complete descriptions and applications of all types of "Megger" Insulation Testers write for Catalog 1685-I.

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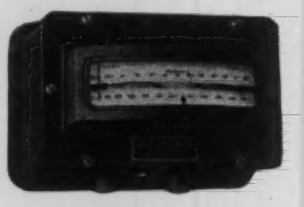

Model W-1
Switchboard Indicator

Unskilled help may handle this direct-deflection instrument, which needs no manual adjustment. Designed for numerous ranges of temperature, both F. and C.

Write for descriptive Bulletin 400

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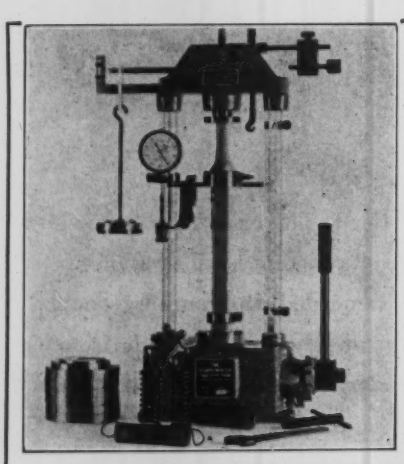

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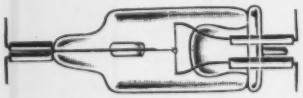
such as forestry, emergency, police, and marine, which operate with AM transmitters. It is not intended for broadcast service. Modulation percentage is indicated on a direct-reading hermetically-sealed instrument which is flush-mounted on a panel approx. 4" square. Elimination of vacuum tubes, batteries, and need for a-c. line input is accomplished through application of Sylvania germanium crystal diode "Type 1N34." Instrument permits determination of modulation percentage of either a sine-wave-modulated or a voice-modulated carrier; also gives an indication of carrier shift. It thus enables user to avoid under-modulation, helps him to keep his transmitter efficiency high, enables him to avoid overmodulation with its distortion and excessive frequency spread—the latter prohibited by FCC regulations. Convenient audible check on hum and audible distortion may also be made in conjunction with crystal or high-impedance magnetic earphones. "Type X-7018" measures 4" wide, 4" high, and 4¼" deep; weighs less than 2½ lbs. It is supplied with a 75-ohm twin-lead transmission line for use with an external link circuit; input terminal strip for external link; toggle switches; trimmer capacitor for peaking of input circuit; and jack to disconnect meter and insert phones for audible signal check.—*Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y.*

Please mention number 124 when filling out card

Improved UHF Vacuum Thermocouples

New "Type U" vacuum thermocouples for measurement of current, voltage, and power at ultra-high frequencies, embody an improvement: Evacuating tip, previously positioned at side of bulb, has been re-

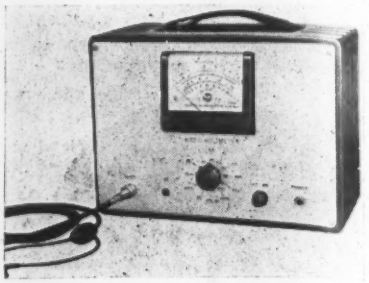


moved and is now located coaxial with stem, as shown in illustration. It is therefore possible to mount these thermocouples within coaxial cables or within fittings of restricted space, thereby providing improved shielding.—*Field Electrical Instrument Co., 109 East 184th St., New York 53, N. Y.*

Please mention number 125 when filling out card

Voltmeter for Audio-frequency Testing

New "Type WV-73A Audio Voltmeter" for use in industry, laboratory, and radio servicing, is a vacuum-tube instrument designed to measure a-c. voltages over ranges of frequency and amplitude "far beyond the limits of ordinary a-c. voltmeters." Its sensitivity makes it possible to measure electrical conductance of switches, circuit breakers, relays, buses and grounds, in addition to transmission losses in lines and circuits and the response of special filters and compensators. It is also applicable for testing radio receivers and sound systems; also for measuring gain and noise level in power amplifiers and ripple voltages in power supplies; also for locating sources of frequency distortion and faulty amplifier components in receivers, etc. Its range is 20 cycles to 20 kilocycles. Main components are a precision attenuator, a three-stage high-gain stabilized amplifier, a balanced diode rectifier, a special d-c. microammeter, and a regulated power supply. Voltage to be measured is fed to attenuator through a shielded cable attached to a jack on front panel. Attenuator consists of an eleven-position switch connected to non-inductive resistors, arranged in such an order that consecutive switching ranges overlap by 10 decibels. Measuring range is 0.001 volt to 1000 volts. From attenuator, voltage is fed to high-gain amplifier which employs a conventional feedback circuit to obtain stabilization and sharply reduces input capacitance of first tube. Output voltages from this amplifier are fed to a balanced diode rectifier in order to produce d.c. for energizing the microammeter. High-level rectifier is designed to produce an output voltage proportional to average value of

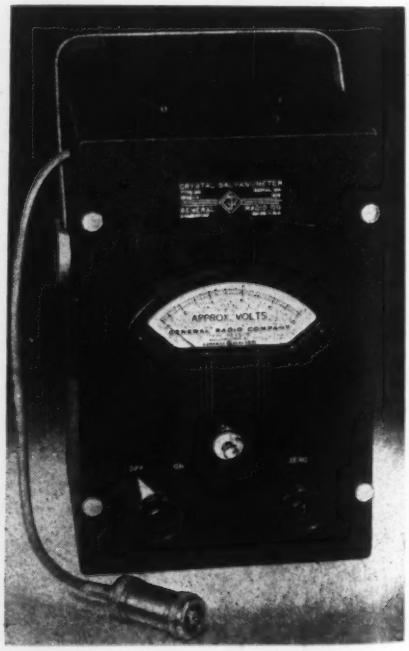


full wave, thereby giving a reading that agrees closely with an RMS meter for all usual distorted wave-forms. Because a balanced diode rectifier is used, microammeter indicates true value of both halves of the wave, avoiding polarity or "turn-over" error of half-wave circuits.—*Engineering Products Dep't, RCA Victor Div., Radio Corp. of America, Camden, N. J.*

Please mention number 126 when filling out card

UHF Voltmeter

New "Type 1802-A" ultra-high-frequency voltmeter, for direct voltage measurements in the UHF range, is similar in principle of operation to the peak-reading type of vacuum-tube voltmeter, consisting of a rectifier and a d-c. amplifier, but uses a standard type of crystal rectifier in the probe, in place of the conventional thermionic diode. Excellent high-frequency characteristics of these crystals make possible their use as rectifiers at frequencies well beyond the range of vacuum tubes. Range of new instrument is 0.1 volt to 1 volt, and decade multipliers to fit the probe are supplied for multiplying factors of 10 and 100. Accuracy of indication is ±5%, subject to frequency correction, curves for which are furnished. Frequency range for direct voltage measurements is from 10 to 1000 Mc., but voltage-ratio measurements can be made at frequencies well above 1000 Mc. while, as a simple voltage indicator, instrument will



operate up to about 3000 Mc. A coaxial adaptor and a 50-ohm disk-type terminating resistor are supplied in addition to multipliers. Cathode and plate power for the d-c. amplifier is obtained from self-contained batteries. Input capacitance depends upon the crystal; input conductance upon frequency, voltage-level, and crystal. Representative values are 5 $\mu\mu f$ and 100 micromhos. Over-all dimensions are 7" × 7" × 3½". Net weight is 10¾ lbs.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

Please mention number 127 when filling out card

High-frequency Voltmeter

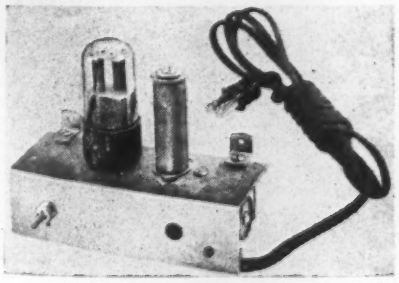
New "Model 32 High Frequency Electronic Voltmeter" is equipped with a radio-frequency probe having the extremely low input capacitance of ¾ micro-microfarad, is claimed to extend the range of measurement "ten times—from 50 to 500 megacycles." "Model 32" offers better than 5%

of full-scale accuracy on all ranges and sinusoidal voltages; it measures 0.3 to 300 volts r-f. in five ranges (3, 10, 30, 100 and 300 volts full scale). Frequency range is 500 kc. to 500 Mc. Input impedance: ¾ $\mu\mu f$ at a *Q* of about 200. Power supply: 115 volts, 60 cycles, 30 watts. Tubes: one 6AL5 in probe, two matched 6J6 and one 6X5GT rectifier. New voltmeter measures 5½" × 9⅛" × 9½", weighs 8 lbs., is suitable for general use in laboratory, on test bench, or on production line.—*Alfred W. Barber Labs., 34-14 Francis Lewis Blvd., Flushing, N. Y.*

Please mention number 128 when filling out card

Transmitting Attachment

New "phono oscillator" makes it possible to link any record player with any standard broadcast receiver. No wire connections between the record player and the radio are required. Signal blankets ordinary static or extraneous noise when unit is located within 50 feet of receiver, so that various indus-



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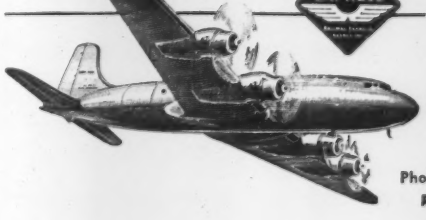

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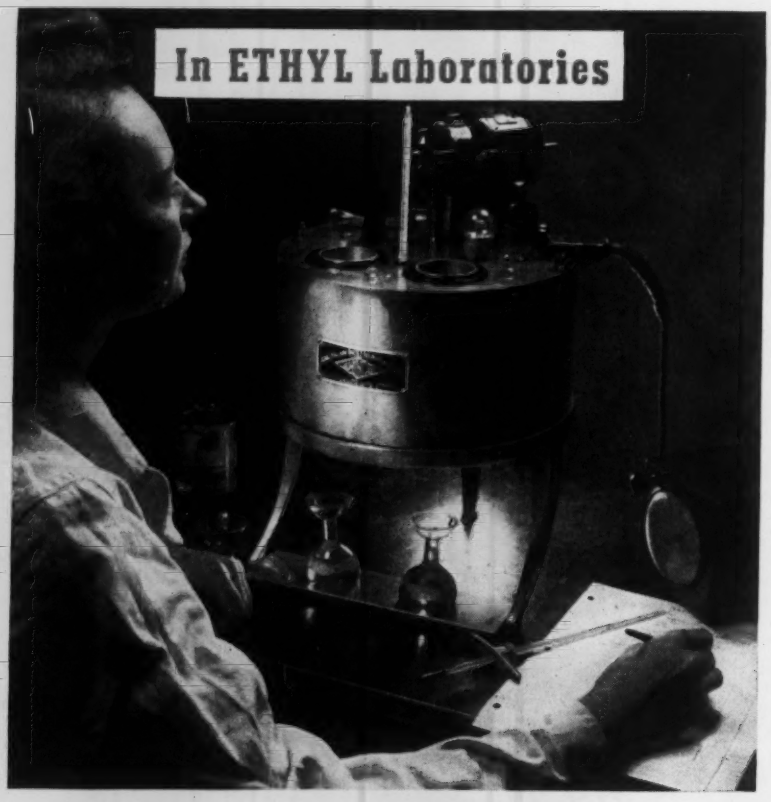

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trial uses are possible. Dimensions, 2" wide, 5¼" long, 4¼" high; weight 12 oz. including tube, a dual-purpose 12SL7. Transmitting frequency may be permeability tuned from 550 to 1550 kc. Units are shipped tuned to 600 kc.—*D & M Mfg. Company, 51 Lincoln Ave., Midland Park, N. J.*

Please mention number 129 when filling out card

Tubular Slide-contact Rheostat

New "Type E" incorporates features of maker's older models, plus "Floating Contact Element" (Fig. 2) which consists of two copper-graphite contact blocks connect-

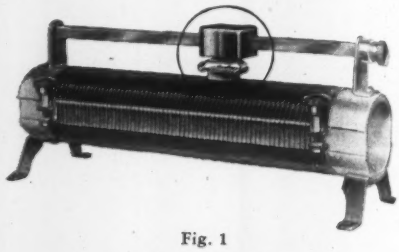


Fig. 1

ed by a phosphor-bronze leaf spring. Copper-graphite blocks not only have a low intermediate resistance if proper contact pressure is applied, but also lubricate the sliding path. Upper block (which has no rigid connection with slider knob but moves freely in the hole at its bottom) makes contact with slider bar, while lower one slides on winding. Sticking of moving member is said to be impossible because both

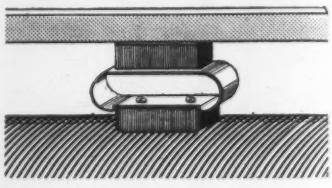


Fig. 2

sliding paths are lubricated. Abrasion and tear of "even the finest resistance wire" are said to be eliminated. Porcelain tube is glazed inside and outside and two lengthwise recesses keep winding in tight position by their sharp edges. New rheostat is manufactured in one size—450 watt, in 16 ohmic values (others can be supplied on request). New rheostat can be furnished with non-inductive and also with tapered winding.—*Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, L. I., N. Y.*

Please mention number 130 when filling out card

Capacitor Analyzer

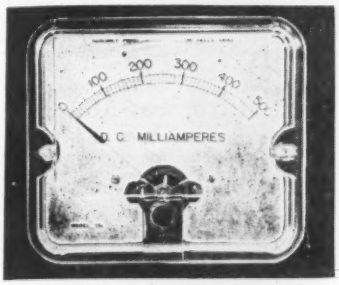
New "Model CBB" Capacitor Analyzer, especially designed for radio and electrical service industry, is a small, light-weight version of maker's "Model CB" with improved components for use in humid cli-

mates, and has an extended capacitance range to measure capacitors from 10 mmf to 800 mf. A "Magic Eye" tube is used for Wien bridge balance indication, while simplified neon lamp test circuits are used for visual checks of insulation resistance of electrostatic capacitors and leakage current of electrolytic capacitors. Instrument may also be used as a line-frequency resistance bridge covering a range of 50 ohms to 2 megohms.—*Solar Mfg. Corp., 285 Madison Avenue, New York 17, N. Y.*

Please mention number 131 when filling out card

Electrical Indicating Instruments

New line of panel instruments feature a crystal clear plastic case which is said will dress up new electrical apparatus, fits well into modern design and adds a touch of distinction. No shadows are cast on the dial by the full-view, unbreakable front cover. Light played on edges of case from

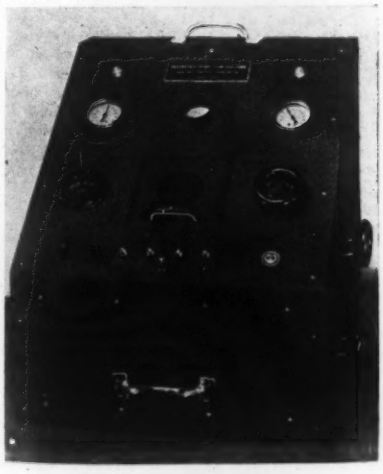


rear will "pipe" through plastic to cast soft illumination on scale. Movements are accurately balanced, with polished pivots and vee jewels. D-c. instruments are moving-coil permanent-magnet type; a-c. instruments are repulsion iron vane type. Air chamber damping prevents excessive oscillation. All popular ranges of volts, millivolts, milliamperes or amperes, as well as rectifier type and thermocouple r-f. instruments can be supplied. New instrument measures 3¾" wide by 3⅝" high; all-clear front allows a scale length of 3".—*Assembly Products Inc., Main & Bell Sts., Cragrin Falls, Ohio.*

Please mention number 132 when filling out card

Spark Plug Analyzer

New "Model SP22 Electronic Spark Plug Analyzer" (developed for U.S. Army Air Forces) provides a "fool-proof" means for testing airplane and automotive spark plugs. Indicator is a simplified oscillographic type that can be operated readily by inexperienced personnel. All test characteristics under pressures between atmospheric and 600 lbs./in.^{2} and at voltages between 1000 and 21,000 volts peak can be determined



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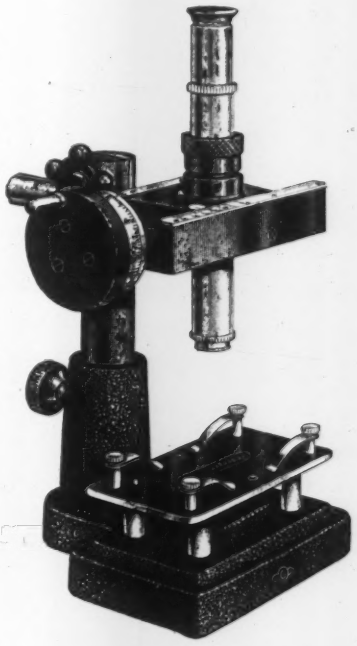

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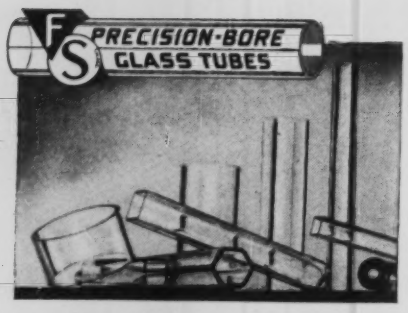

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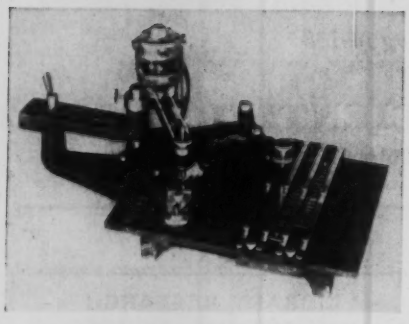

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rapidly with new apparatus. Corona discharge, leakage, "spark-over" and insulation losses and faults are indicated by patterns obtained. High-tension ignition cable can also be tested with "SP22." Modifications of this instrument are also available for application to other high-voltage insulation resistance, corona and breakdown testing. "SP22" is approx. 20″ wide by 20″ deep by 22″ high.—*Rowe Radio Research Lab. Co., 2422 N. Pulaski Road, Chicago 39, Illinois.*

Please mention number 133 when filling out card

V-block Type Pneumatic Comparator Gage

New V-block type of air-gaging member for use with maker's Pneumatic Comparator Gage, may be supplied for simultaneous measurement of one, two, or more outside

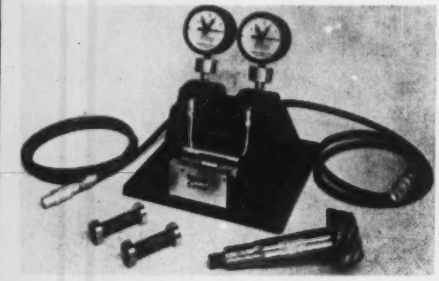

Fig. 1

diameters as small as 0.150″ or as large as 8″. Instrument illustrated measures two diameters on the pinion shaft and is used by an automobile manufacturer for selecting parts within 0.00005″. Rotating the part in the gage checks out-of-round, and sliding the part axially checks taper. Maximum and minimum masters, by which the gage is set, are shown in foreground of Fig. 1. Weight of inspected part is carried on tungsten carbide wear strips, so that the V-block-type unit is practically unaffected by wear. The nozzles which perform

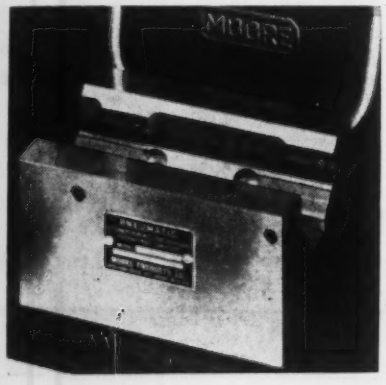

Fig. 2

the measuring are recessed below the surface. Dirt, oil and coolant on the work have no effect on accuracy of measurement, so that new gage can be installed right at the grinding machine. New gage is equipped with "Moore Adjustable Compensator" which permits positioning the magnification on standard calibrated dials with interchangeable gaging members of various types and sizes.—*Moore Products Co., H. & Lycoming Streets, Philadelphia 24, Penna.*

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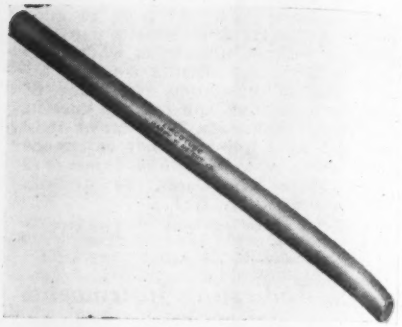
Combustion Tubes

New "Zircotube" zirconium refractory base combustion tubes are for use in carbon and sulfur analysis. They are said to incorporate design and materials carefully chosen and processed to give tubes which

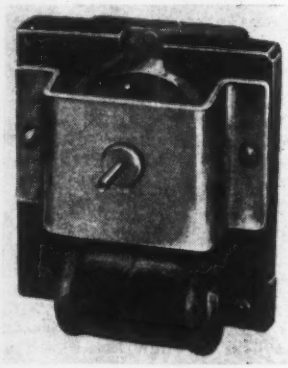


will withstand high temperatures, withstand thermal shock and resist metal splatter. Other desirable characteristics offered are said to be accuracy in size, gas tightness, and extra long life at temperatures up to 2800°. "Zircotube" combustion tubes are available in a complete line of sizes, restricted and open ends.—*Harry W. Dietert Co., 9330 Roselawn Avenue, Detroit 4, Mich.*

Please mention number 135 when filling out card

D-c. Instrument Motor

New "Alni Minimotor" is said to be a radically new self-starting, permanent magnet type, miniature d-c. motor. It is de-



signed to self-start in only one direction, regardless of polarity reversal. New motors are manufactured with different field coil windings for operation on various voltages, and various bearing designs are available to meet individual requirements. "Model 2000-2" (illustrated) weighs 2¼ ounces, measures 1¾ × 1¾″ × ⅞″.—*Alni Corp., 10 E. 52 Street, New York 22, N. Y.*

Please mention number 136 when filling out card

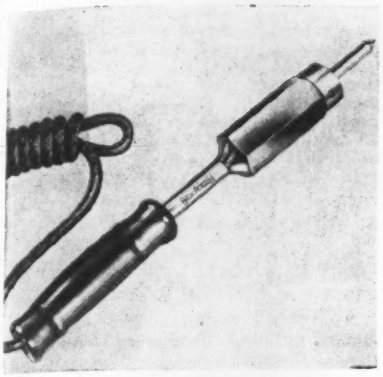
Industrial Thermometer

New "Senior Midget" separable-socket industrial thermometer is said to eliminate necessity of returning thermometer to factory for repair, and to make it possible for maintenance man to insert a new refill stem in a few minutes, without loss of production time. "Senior Midget" is available in angle and straight stem types with heavy armor protection to resist corrosion and dirt. It is equipped with flat bore mercury stripe in a yellow stem, for easy reading.—*Accuracy Scientific Instrument Co., 2903 N. 12th St., Philadelphia 33, Pa.*

Please mention number 137 when filling out card

Soldering Iron

New "No. P-338" industrial electric soldering iron is wound for 300 watts, but has a ⅜″ instead of conventional ⅞″ diameter tip. This new construction is said to provide extremely high heat for a small tip cross-section and to permit "faster soldering on heavy work." Expense of tip replacement is reduced when compared with the usual ⅞″ tip. Heating element is housed in damage-proof hexagon-shaped barrel,

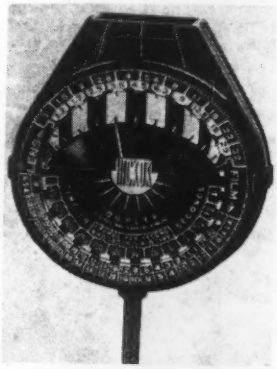


whereby iron can be held in vise when replacing tip. Metal stand furnished with each iron. Heating elements made of best grade nickel-chromium resistance wire insulated with mica. Terminals easily accessible and constructed to relieve cord strain. Operates on a.c. or d.c., any cycle, specify voltage when ordering.—*Hexacon Electric Co., 179 West Clay Ave., Roselle Park, N. J.*

Please mention number 138 when filling out card

Exposure Meter

New model of "Duplex Exposuremeter" has new shatter-proof plastic case, new direct-reading dial for readings up to *F*.32, higher light sensitivity than previous model

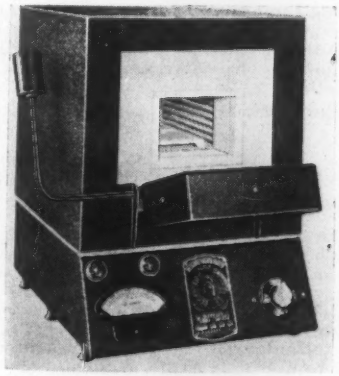


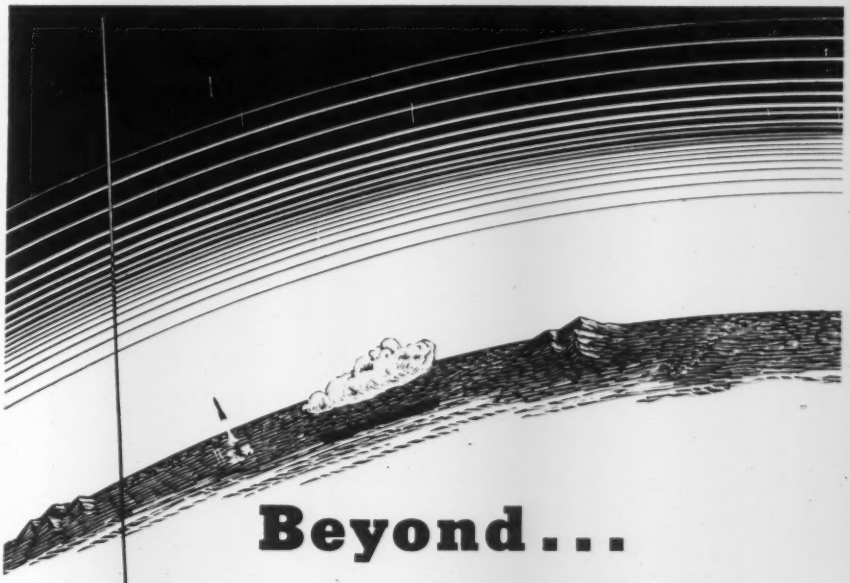
and new shock-proof movement, is suitable for movies and color photography. New A.S.A. scale of emulsion speeds is included with W. scale.—*The Hickok Electrical Instrument Co., 10519 Dupont Avenue, Cleveland 8, Ohio.*

Please mention number 139 when filling out card

Laboratory Furnace

New "No. 5 De Luxe" automatically-controlled furnace features a combination three-way heat range switch and an automatic temperature timer which allows operator to maintain constant temperatures





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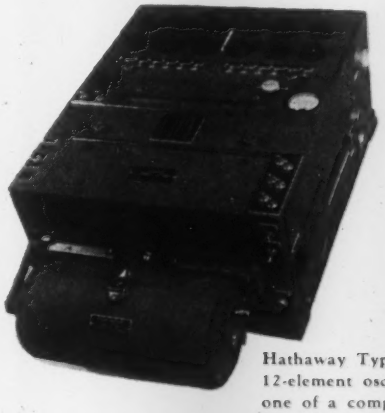

Hathaway Type S8-B 12-element oscillograph—one of a complete line of recording oscillographs

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Hathaway
INSTRUMENT COMPANY
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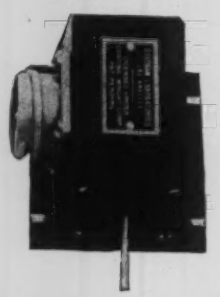
The STATHAM GAGE

MODEL YE



Displacements as minute as 0.000008" or Force Changes as small as 0.02 oz. are readily detected by the Statham Gage without expensive electronic equipment.

Complete system for remote indication comprises Statham Gage, dry cells, and panel type microammeter or recording galvanometer.

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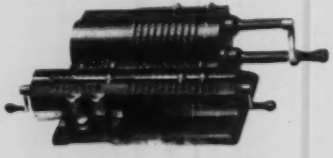

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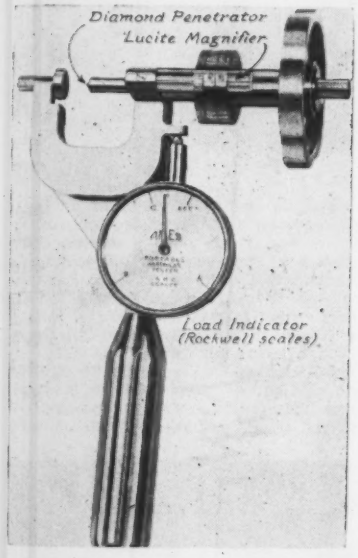
ranging from 200 to 1800°F. with a minimum variation of not more than 10°, and also to bring the furnace to heat fast or slow as desired. Heating elements are of high-temperature alloy wire; furnace itself is of all-steel construction, insulated. Door is counterbalanced to insure complete closure while in operation. Furnace proper is divided by a Transite spacer from lower base where instruments are located. Built-in temperature controller and heat range switch, a pyrometer, two porcelain loading trays, and two pilot lights for indicating furnace operation are included as standard equipment. Dimensions of work chamber, 4¾" × 3¾" × 9"; over-all dimensions, 19" × 21" × 21"; furnace throat, 2". Maximum operating temperature is 2,000°F. —*K. H. Huppert Co., 6830 Cottage Grove Ave., Chicago 37, Illinois.*

Please mention number 140 when filling out card

Portable Hardness Tester

New "Ames Hardness Tester" is a portable instrument (weight 2 lbs.) for hardness determination by Rockwell penetration method. A diamond-point penetrator is used

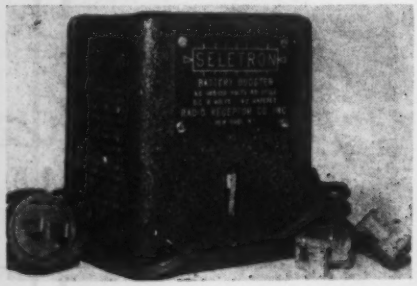


in testing hard materials in Rockwell "C" scale; a ball-point penetrator for "B" scale, Pressure applied by screw causes C-shaped frame to deflect, thereby moving indicator pointer to dial markings for standard loads. Penetration is then read on barrel dial which is graduated in both Rockwell "B" and "C" scales. Throat capacity, 1". Accessories include a V-shaped anvil, two test blocks and Brinell conversion chart.—*B. C. Ames Precision Machine Works, Waltham, Mass.*

Please mention number 141 when filling out card

Battery Booster

New light-weight automatic constant-voltage battery charger is especially designed for industrial plants using single 6-volt storage batteries for operation of alarm or signal systems, control apparatus, etc.,

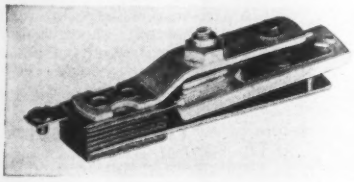


conservatively rated at 4-2 amperes, will supply 5 amperes for a short period of time. It is completely automatic. Dimensions 4" × 4" × 5", weight 4 lbs. packed. Perforations in sides and base give ample ventilation. Operates on 105-120 volts a-c, 60 cycles. D-c., 6 volts, 4-2 amperes.—*Seletron Div. Radio Receptor Co., 251 West 19th St., New York 11, N. Y.*

Please mention number 142 when filling out card

Snap-action Thermal Cut-out Switch

New "Type RM Ula-Snap" has been designed to meet increasing demand for a rugged thermal cut-out switch that will cut off machines or appliances and remain inoperative until reset. This new mica-insulated unit is pile constructed and corrosion

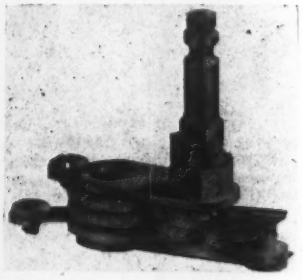


protected. It will cut out at any predetermined temperature and can be reset by pushing a simple fibre button. "Ula-Snap" is rated at 1500 watts, 110-220 volts a.c. and operates at temperature ranges of 0-150°F., 0-300°F., 0-700°F. Two mounting holes with 5/16" centers are provided. Overall sizes including terminals is 1"h. × 1"w × 3½" long.—*George Ulanet Co., 413-41[illegible] Market St., Newark 5, N. J.*

Please mention number 143 when filling out card

Bimetal-type Thermostat

New "Type S" adjustable bimetal thermostat is precalibrated at factory. Bimetal element carries no operating current. Heavy-duty silver contacts are spot-welded



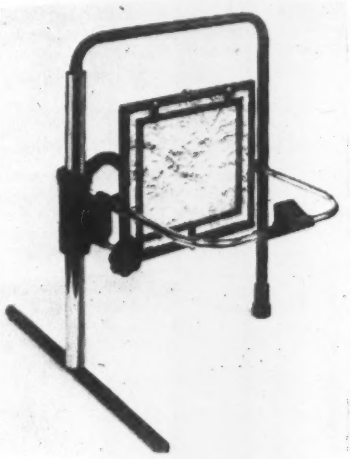
to contact springs. Thermostat units can be supplied with either lava or mica insulation. Simplified mounting is a feature: A single through hole provides for quick mounting with either screw or stud. Unit is supplied with either standard or elevated terminals. Heating capacity of thermostat is listed as 15 amperes, 115 volts a.c. Double threaded adjusting stems are available in a variety of lengths and styles. Typical applications are ironing machines, hot plates, etc.—*Stevens Mfg. Co., Mansfield, Ohio.*

Please mention number 144 when filling out card

Camera-lucida-type Mapping Instrument

New "Rectoplanigraph" is a new type of portable mapping instrument, designed to provide the map-maker with a simple means of rectifying and transferring planimetric detail from aerial photographs to maps and charts. Utilizing camera lucida principle, "Rectoplanigraph" is said to be extremely easy to use. It is easily assembled and dis-

assembled, and can be set on a drafting table. Its design provides indexed adjustments for three focal lengths (6", 8¼" and 12"), a micrometer adjustment for all variations in scale, and other adjustments for rectification of the photographs to compensate for errors introduced by tip and tilt. A picture-holder is fitted with masks to accommodate air-photos ranging from 4" × 5" to 9" × 9". A high-quality prism (used instead of half-silvered mirrors) assures a sharp, well-illuminated image. In using "Rectoplanigraph," map-maker views a vertical or oblique aerial photograph, mounted in the picture-holder, through a peep-sight attached to an eye-piece arbor. He then aligns ground control on photograph with

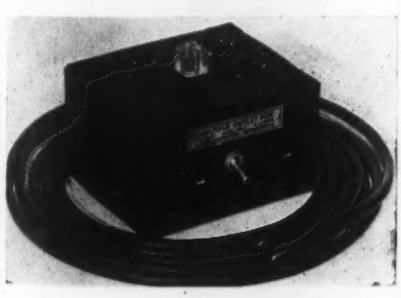


corresponding control on the chart lying before him under eye-piece. He does this by making adjustments for focal length of camera used in taking aerial photographs, and by using micrometer adjustment to bring image to proper scale; he refers to fiducial marks on photograph for lining up photograph with optical system; he finally makes an additional adjustment to rectify for tip and tilt. When all adjustments have been made, he traces desired supplementary detail on map or chart by following image of lines from photo. New "Rectoplanigraph" is said to fill a long-felt need in map-making: as a companion piece to more elaborate stereoscopic mapping instruments, it enables map-maker to fill in secondary details quickly after major control points have been established.—*Fairchild Camera & Instrument Corp., Jamaica, N. Y.*

Please mention number 145 when filling out card

Octuple Outlet Boxes

New "Model 3001-A Multi-Plug" Outlet Box solves problem of coping with an insufficient number of wall outlets. It contains eight standard receptacles, can be plugged into any 110-125-volt a-c. or d-c. wall outlet, is designed for laboratories, schools, factories, hospitals, etc. Boxes can be "pyramided": one can be plugged into another. Two 15-amp. fuses protect main line against shorts and overloads. A neon pilot light (1/25 watt) tells a.c. from d.c. and signals "voltage on all plugs"; a long-



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MODEL J
TRIPLE RANGE CENTRIFUGAL
Cat. No. 312 300-12,000 RPM
Cat. No. 1412 100-12,000 RPM
SINGLE RANGES
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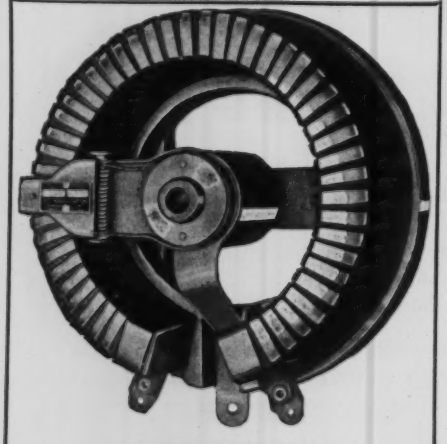

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stroke toggle switch breaks both legs of line. Unit is supplied with 12 feet of heavy-duty rubber appliance cord. It is completely metal-enclosed; all components are Underwriters approved. Cabinet dimensions, 3" × 4" × 5"; net weight 1 lb. 9 oz.; shipping weight, 1 lb. 12 oz. Unit can be supplied with female adapters for British-type plugs, and a plug for British-type receptacles. "Model 3002-A" is of use on 220-250 volts, and has 7½-amp. fuses.—Manufactured by Allied Laboratory Instrument Co.; Available from *Sun Radio & Electronics Co., Inc. 122-124 Duane Street, New York 7, N. Y.*

Please mention number 146 when filling out card

High-current Feed-through Filter Capacitors

New small, light-weight 3-terminal network filter capacitors, capable of continuous use at currents up to 100 amperes with line voltages up to 250 volts a.c., were originally developed for wartime applications in attenuating radio interference from motors, generators, etc., used by Army, Navy and Air Forces; are available in values up to 0.75 mf. They are hermetically sealed and furnished in corrosion-resistant metal housings.—*Solar Mfg. Corp., 285 Madison Avenue, New York 17, N. Y.*

Please mention number 147 when filling out card

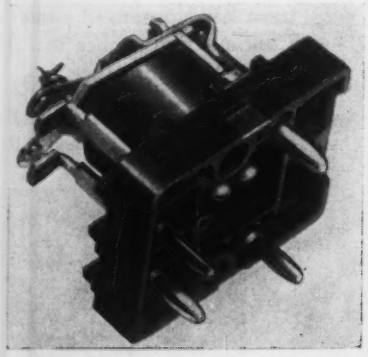
Resonant Relays

New "Type 182" Resonant Relay uses a vibrating-reed mechanism adjusted at factory to respond to a narrow band of frequencies and to reject all others. A small amount of energy received by the relay at its resonant frequency causes contacts to vibrate. These contacts, in turn, are connected in series between power supply and circuit to be controlled. When relay operates, current from power supply is delivered to circuit to be controlled in pulses at relay's resonant frequency. This pulsating current is obviously not suitable for direct control purposes and, when "off-on" switching of a substantial amount of power is wanted, a conventional, slow-acting relay is used as an auxiliary "working" relay. Example of such an application: switching of "off-peak" water heaters. No auxiliary relay is needed for electronic applications of Resonant Relay. In these cases, grid of thyratron is triggered directly from vibrating contacts of Resonant Relay.—*Stevens-Arnold Co., 22 Elkins St., South Boston, Mass.*

Please mention number 148 when filling out card

Midget Magnetic Relays

New "Bulletin 106 Midget Magnetic Relays" are designed for application in industrial, electronic and control circuits where remote or automatic operation is required; are suitable for a.c. or d.c. to standard voltages and frequencies up to 125 volts; are available with single- or double-pole and single- or double-throw silver contacts. Single-break contact ratings for standard relays are 4 amperes, 125 volts a.c. 60 cycles on non-inductive loads. New relays are of open type mounted on a moulded phenolic insulating base and, where enclosures are required, Bakelite covers, steel covers, watertight boxes, etc., may be supplied. Relays are available for two-wire or three-wire instrument control. A novel feature of these 106 relays includes those provided with pin plug connectors permitting mounting by plugging relay in receptacles installed in panelboard. This mounting method permits complete wiring of a circuit before relay is placed on panel, facilitating quick replacement and periodic testing where required.—*Ward Leonard Electric Co., Mount Vernon, N. Y.*



Please mention number 149 when filling out card

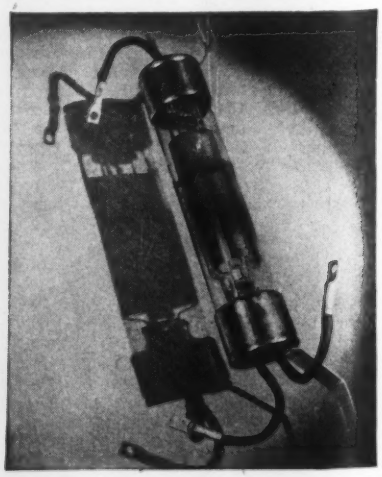
High-speed D-c. Relay

New "Millisec Relay" has an operating time of one millisecond or less. It is assembled in a standard metal radio tube container but its operation is mechanical and not electronic. It is made in one size, single-pole double-throw, for use with resistive loads. When used with an inductive load, special tests are required at factory in conjunction with actual load. Only d.c. is used on the contacts; a.c. is not recommended. Contact rating is 110 volts d.c., ½ ampere. Life expectancy varies from 22,000,000 operations to 100,000,000 operations at ¼ ampere. Coils are wound for d.c. only, either 18 volts, 1400 ohms or 6 volts, 150 ohms. A feature of new relay is said to be its freedom from bounce, made possible by an ingenious shock-absorbing mechanism. This permits its use as a square-wave generator by applying a.c. to the coil and d.c. to the contacts.—*Stevens-Arnold Co., 22 Elkins St., South Boston, Mass.*

Please mention number 150 when filling out card

Half-wave Rectifier Tube

New "Type EL 16F" half-wave xenon-filled rectifier tube is designed for direct mounting on a panel without socket, thereby eliminating the socket. Characteristics: Average anode current, 16 amps.; Peak



anode current, 96 amps.; Peak inverse voltage, 620 volts; Average arc drop, 7 volts; Filament voltage, 2.5 volts; Independent of surrounding temperature. Applications: "EL 16F" tubes may be used in rectifier circuits giving up to 96 amperes d.c. at voltages varying from 24 to 600 volts d.c., for supplying d-c. motors, magnets and batteries. Special circuits may be used for powering vibratory motors.—*Electrons Incorporated, 127 Sussex Avenue, Newark 4, N. J.*

Please mention number 151 when filling out card

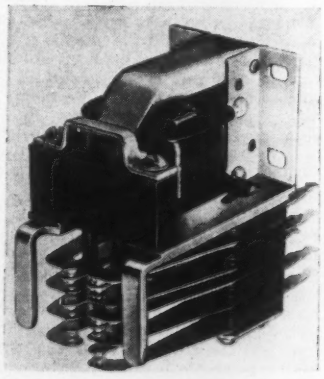
Miniature Cold-cathode Relay Tube

New "Type OA5" five-element internally-triggered miniature cold-cathode relay tube is a strobotron type, 1⅝" overall and 1 1/16" in diameter; reduces delay in firing from 100 to 1 microsecond; has stable triggering characteristics throughout life; and is designed for positive-pulse, low-current triggering on trigger grid. These characteristics are said to make it ideal for photoflash and similar applications where manual trip, built-in shutter synchronizing, or photocell switching is used. Used in photocell-controlled equipments, new tube permits simultaneous control of any number of flash units without interconnecting cables. Unusually low trigger currents eliminate shock hazard and switch contact arcing. Typical operating characteristics: Anode, volts, 750; Trigger grid bias, volts, +90; Trigger grid resistance, 0.25 megohms; Discharge capacitor, 0.25 mfd; Keep-alive current, 50 microamperes; Trigger pulse, 85 volts; Ambient temperature, —40°C to 60°C. Circuits may be used employing either a sufficiently high positive trigger pulse, or a smaller pulse with a fixed positive bias. New tube may be mounted in any position and is supplied with miniature button seven-pin base. It is licensed under Edgerton, Germeshausen and Grier patents.—*Electronics Div., Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y.*

Please mention number 152 when filling out card

A-c. Relay

New a-c. relay was designed to fill need for a fast-acting, reliable, compact relay for maker's vehicle-actuated traffic control systems, hence is suitable for numerous industrial applications. It stands up in traffic



control systems under duty as high as 10,000,000 operations per year. A circuit closure of as little as 0.01 second operates

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3 The ambient temperature at which above values are to be measured.
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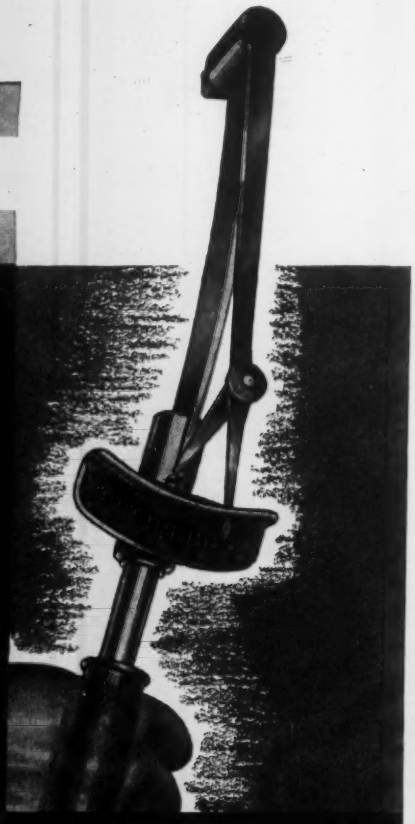
TORQUE WRENCH

-HEAR-FEEL-SEE-



World's fastest Production Wrench—is the world's most accurate too!

Reflex Torque Control by sight, sound and feel—automatically fast, involuntarily accurate.

Set to desired torque in a few seconds—no further adjustments.

No wearing or moving parts in measuring element—no gears, levers, glass dials or fragile mechanisms.

Permanently Accurate Torque Wrenches—with automatically accurate operation.

The world's largest Manufacturer of Torque Wrenches—31 capacities.

Write for Bulletin No. 13

P A Sturtevant Co.
ADDISON QUALITY ILLINOIS

"POWER TO BURN"

Littelfuse precision-built fuses are so inexpensive that every manufacturer can effectively protect his product and reputation at relatively small cost. Complete range of types and sizes for instruments, small motors, radio and electronic circuits, automobile, aircraft and marine instruments, and all types of electrical equipment. For complete information on these and other Littelfuse quality products, send for Catalog No. 9 . . . just off the press.

FUSE EXTRACTOR POST for 8AG fuses. Finger operated. Also available with screw-driver slot knob. A quicker, safer, simpler method for mounting and changing fuses.

METER-BACK MOUNTING for 8AG fuses. Mounts direct on one meter binding post and wire connects to screw terminal of Mounting. Overall length only 1 1/2".

8AG FUSE. "Quicker than a short circuit." Precision designed and built. Note bridge-type construction which protects the delicate filaments in fuses of very low fractional amperage.

LITTELFUSE FIRST IN CIRCUIT PROTECTION *Incorporated*

4785 N. RAVENSWOOD AVE. CHICAGO 40, U.S.A.

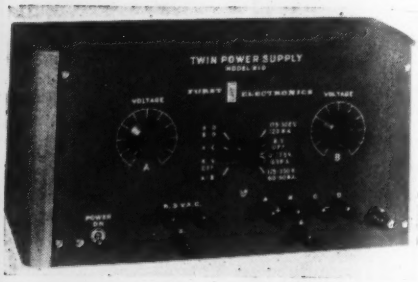
NITE-T-LITE • SWITCH-LITE • IGNITION-FRITZ • NEON INDICATORS • SWITCHES • CIRCUIT BREAKERS • FUSES, MOUNTINGS AND ACCESSORIES

relay cleanly. As many as 10 individual pairs of contacts can be accommodated on each relay. To meet requirement of high insulation resistance—in excess of 300 megohms from any contact spring to any other spring or ground—a method of individually encasing each contact spring in phenolic insulation was perfected. Coils for 115 volts, 60 cycles, and 12 volts, 60 cycles, and pure silver contacts 5/32" diameter (rated 5 amp. 115-volt a-c. non-inductive) and 7/32" diameter (rated 10 amps. 115-volt a-c. non-inductive) are standard. Other contacts and coils can be supplied on special order. Any combination of normally-open, normally-closed, break-make, make-before-break, or break-make-before-break, can be assembled in any relay.—*Automatic Signal Div., Eastern Industries, Inc., East Norwalk, Conn.*

Please mention number 153 when filling out card

Twin D-c. Power Supply

New "Model 210 Twin Power Supply" features two independent adjustable-output d-c. voltages which remain constant to 1% or 1 volt regardless of variations of power



line and load connected to each output. A selector switch on front panel also allows an internal connection of these two outputs either in parallel, or in series, so that either twice normal current, or half normal voltage can be obtained.—*Furst Electronics, 800 W. North Ave., Chicago 22, Illinois.*

Please mention number 154 when filling out card

Solderless-fixture Type Splicing Connector

New "AMP Closed-End Connector" is said to make pigtail splices that will not loosen, even under the conditions of continuous vibration encountered in appliance motors, etc. Furnished with insulation al-

ready attached, new connector makes a permanent, insulated splice with a single operation of AMP hand tool or press die without necessity of soldering, wire twisting, or taping. Insulating sleeve extends beyond metal barrel of connector, completely covering and protecting ends of wire insulation.—*Aircraft-Marine Products Inc., 1591-I North 4th St., Harrisburg, Pa.*

Please mention number 155 when filling out card

Battery Charger-tester

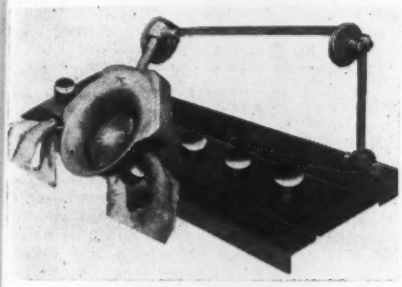
New portwar model of "Willard Fast Charger-tester" is described as providing scientifically accurate method of determining battery condition and of fast charging a battery with completely assured safety. Illuminated indicators and expanded illuminated scales assure easy readings. Charging is under automatic thermostatic control. Immediately after charge is terminated, battery condition can be determined by a test in which proper compensation is made

for both battery size and for temperature —without which it is said that a worn-out battery may be passed as O.K. or a thoroughly good one condemned to the scrap heap. New Charger-tester is said to embody twenty-five features important to safe, economical operation and to quick, accurate testing. Of these, eight are new in this postwar model—including an over-all before-charge battery test and a new circuit for slow charging from one to six batteries. New unit is fully approved by fire underwriters.—*Willard Storage Battery Co., 246 E. 131st St., Cleveland, Ohio.*

Please mention number 156 when filling out card

Inspection Magnifier

New "Sur-Site" magnifying unit is made in 64 different styles to cover a variety of inspection problems involving close tolerances, detecting flaws in metals and fabrics,



or locating foreign matter in bottled goods. Unit illustrated is one used for inspecting small metal parts. Lenses for these units vary in sizes from 3¾" to 4½" and underside lighting is designed to cover a wide variety of inspection conditions with minimum eye-fatigue to inspectors.—*Surty Mfg. Co., 4141 W. Kinzie St., Chicago 24, Ill.*

Please mention number 157 when filling out card

Midget Self-healing Capacitors

New "Solite" midget self-healing capacitors are of approx. one-fourth to one-third the weight (and range to about one-third the size) of conventional designs now in use. Therefore they meet demand for small capacitors to fit into the new ultra-compact electronic devices coming into the market. Low weight and tiny size are achieved through use of a unique self-healing metallized paper construction, instead of conventional multi-paper and foil construction. In place of aluminum foil, "Solite" capaci-

DECADE SCALING UNIT

TYPE YYZ-1

THIS unit offers the research laboratory a quick and effective means of counting the number of pulses from any desired source. It will prove invaluable in such studies as:

- Nuclear Research
- Radioactivity
- Mass Spectography

In addition it will be found extremely useful:

- For Timing Purposes
- For Counting Rapidly Recurring Phenomena
- For Use in Conjunction with Calculating Machines

For additional information, write: *General Electric Company, Electronics Department, I-6411, Syracuse 1, N. Y.*

GENERAL ELECTRIC

164-P1

PERMOPIVOTS of PERMOMETAL*

*T.M. REG.

- LONG LIFE thru wear and vibration Resistance
- NON-ABRASIVE
- NON-MAGNETIC
- NON-CORROSIVE

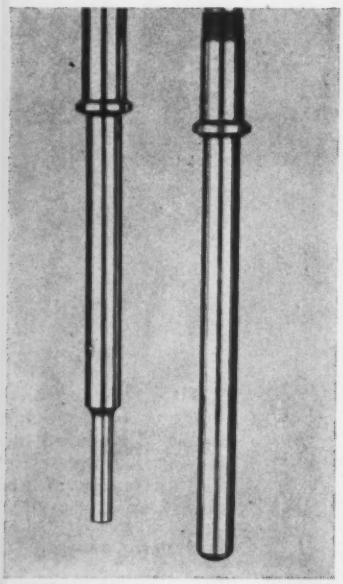
For an illustrated description of how PERMOPIVOTS are made, ask for the new PERMOPIVOT booklet . . . Free on request.

PERMO INCORPORATED CHICAGO 26

MANUFACTURING METALLURGISTS

JERGUSON

Thermocouple - Thermometer WELLS . . .



- **Projected Portion from 3½" up**
- **Stainless Steel or Cold Rolled Steel or Other Alloys**
- **Internal Hydrostatic Tested**
- **Projected Surface Highly Polished to make slightly harder**

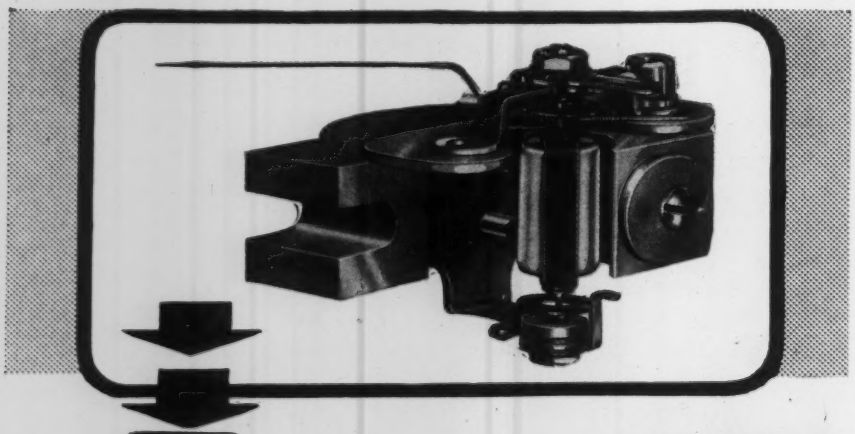
These are the highlights of the JERGUSON Thermocouple-Thermometer WELL for high pressure, high temperature, corrosive conditions. Its heavy construction makes it ideal for such service. Prompt deliveries. Write for prices.

* * *

We have other wells for lighter, less severe service consisting of stainless steel tubing with ends spun and welded; also test wells.

JERGUSON GAGE & VALVE CO.

111 Fellsway, Somerville 45, Mass.



Burlington INSTRUMENTS

Precision Movement . . . Dependability Unlimited

Alinco Magnets in all DC Instruments—Phosphor bronze control springs—perfectly aligned jewel supports—non-shifting balance weights—added to its many other superior construction features enables Burlington Instruments to maintain critical characteristics.

All ranges AC or DC available in 2½", 3½", 4½" sizes, rectangular and round. *Inquiries invited for your specific requirements.*

BURLINGTON INSTRUMENT COMPANY 218 FOURTH STREET BURLINGTON, IOWA

tors have substituted 25- to 100-millimicrons thick metallic coatings deposited on paper. This thin film, permitting use of a single-sheet dielectric, also contributes to self-healing properties of new units. During the course of processing the metallized paper metal inclusions in the paper and weak spots in the tissue are removed, permitting the single tissue to be worked at its maximum electrical stress. If a weak spot should develop in the dielectric, the resulting arc discharge through the paper removes the weakness, and, at the same time, vaporizes the aluminum film around the weak spot, clearing the fault. The aluminum is redeposited as aluminum oxide, an excellent insulating material.—*Solar Mfg. Corp., 285 Madison Ave., New York City.*

Please mention number 158 when filling out card

Automatic-feed Soldering Iron

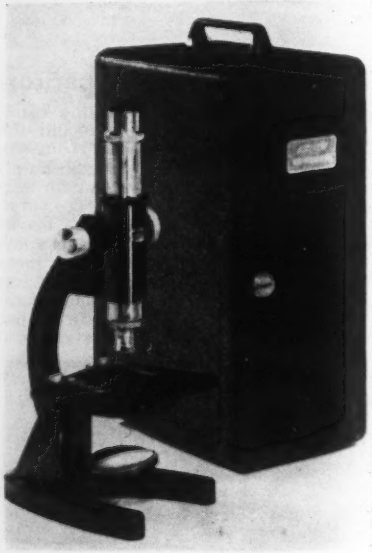
New automatic-feed, electric soldering iron, the "Eject-O-Matic" is trigger operated and ejects a measured amount of solder from a reel concealed in handle. A

special retracting feature prevents the melting of excess solder on the heating tip. The actual amount of solder deposited each time the trigger is pulled is regulated by a micrometer adjusting wheel mounted in the handle of the iron easily accessible to the operator's thumb. Pistol-grip handle is made of molded bakelite. The tool weighs 1¼ lbs. loaded, and is so balanced that it can be used for hours without fatigue.—*Multi-Products Tool Co., 123 Sussex Ave., Newark, N. J.*

Please mention number 159 when filling out card

Microscope

New "Model 40 Standard Microscope," announced as an American-made post-war microscope, is said to incorporate "many features usually found only in much higher priced instruments." It is equipped with two Huygenian eye-pieces (5× and 10× standard Society diameter) which are tapered to afford close eye approach, minimizing interference with field of vision. New microscope will accommodate all standard eyepieces. Convertible (10×-20×) achromatic objective can be changed from high to low power by a flick of the finger. Lens is corrected for chromatic and spherical aberration. Standard Society thread permits interchange with other standard objectives.

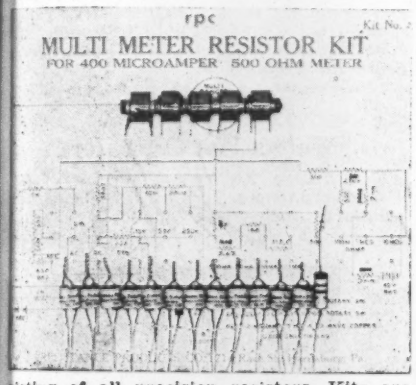


Direct-reading draw-tube provides an additional means of instantly varying magnifying power of instrument: indices (1.1× - 1.2× - 1.3× - 1.4× - 1.5×) are clearly marked on tube; removal of draw-tube from barrel is prevented by a safety catch. Magnification range of 50× to 300× may be still further extended by using additional standard eye-pieces or objectives, all of which are interchangeable with lenses furnished with instrument. Coarse and fine adjustments, combined on one shaft, are mounted on opposite sides of instrument. Coarse adjustment is rack-and-pinion type; fine adjustment is ball-bearing friction type. Safety feature on fine adjustment prevents excessive pressure if objective should contact slide. Objective-tube is secured against casual removal. A bleeder hole in lens mount vents trapped air from barrel so that eyepiece seats immediately when inserted into draw-tube—also prevents ocular from popping out when draw-tube is suddenly lowered. Other features: Full-size stage with slide-clips; optically-ground concave mirror on swivel-mounted sub-stage; six-aperture pivoted sub-stage diaphragm; full-tilting stable frame and base with stops for vertical and horizontal positioning.—*Federal Mfg. & Engineering Corp., 211 Steuben St., Brooklyn 6, N. Y.*

Please mention number 160 when filling out card

Resistor Kits

New additions to maker's line of precision wire wound resistor line are Resistor Kits which come in two types, No. 1 and No. 2. No. 1 Kit is composed of half precision resistors and half matched pair resistors. No. 2 Kit (illustrated) is DeLuxe Model con-

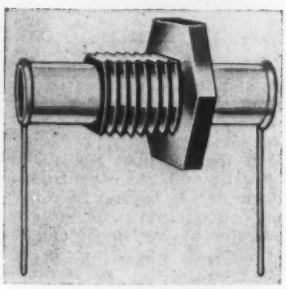


sisting of all precision resistors. Kits are designed for use with "Marion Meter" and Schematic, for building a 400-microampere 500 ohmmeter by radio service men and amateurs. Kits contain all resistors necessary for building a measuring instrument. —*Resistance Products Co., 714 Race St., Harrisburg, Pa.*

Please mention number 161 when filling out card

Feed-through Capacitors

New series of "Hi-Q Feed-thru Capacitors" are fitted with brass cadmium-plated feed-through bushings, are designed to attain efficient by-passing capacitance to ground when feeding through a chassis or metal cover. These new capacitors are of tubular ceramic type. Bushings are securely soldered to the outer electrode. Size range



DEPENDABLE POWER FOR INSTRUMENT APPLICATIONS

Instrument applications of all types require dependable motors which will not fail in constant day-in-day-out service. For this reason, many instrument designers specify Bodine motors on their devices. Years of use in thousands of applications have proved the dependability of these motors in every type of service.

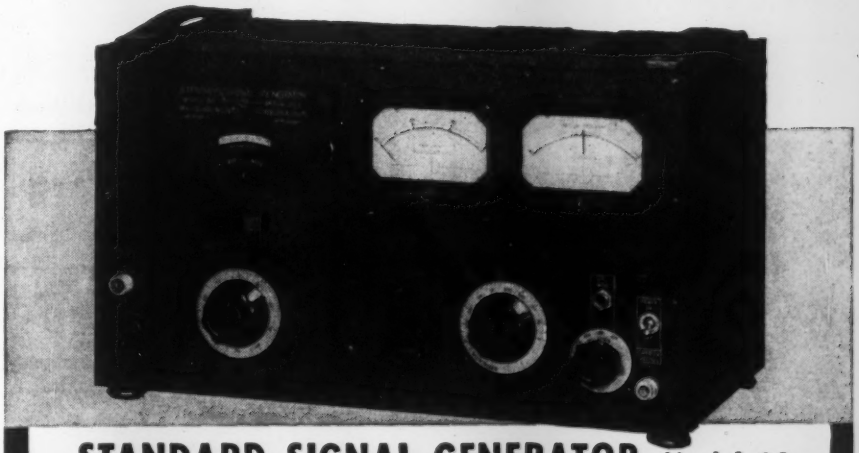
The Bodine Type K motor, shown at right with speed reducer, is a highly dependable source of comparatively small power. It is often used in such instruments as pyrometers sequence or cycle controls, and other devices where reliability is essential and space is at a premium. It is available either with or without the integral speed reducer, and provides up to 1/750, or down to 1/2000, horsepower, at speeds as low as 1 rpm.

Type K Motor with integral speed reducer

If you have an instrument application problem, ask Bodine engineers for help. Their wide experience in selecting the right motor to meet a given application may help you in solving your design problem. Bodine Electric Company, 2244 West Ohio Street, Chicago 12, Illinois.

Engineered for your product

BODINE FRACTIONAL HORSEPOWER MOTORS



STANDARD SIGNAL GENERATOR Model 80

CARRIER FREQUENCY RANGE: 2 to 400 megacycles.

OUTPUT: 0.1 to 100,000 microvolts.
50 ohms output impedance.

MODULATION: A M 0 to 30% at 400 or 1000 cycles internal.
Jack for external audio modulation.
Video modulation jack for connection of external pulse generator.

POWER SUPPLY: 117 volts, 50-60 cycles.

DIMENSIONS: Width 19", Height 10¾", Depth 9½".

WEIGHT: Approximately 35 lbs.
Suitable connection cables and matching pads can be supplied on order.

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
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Keeps an eye on EFFICIENCY!

One sure guide to efficiency is knowing just how your machines are performing. There'll be no guesswork when you're using Corbin Industrial Tachometers!

Ruggedly built, Corbin Tachometers embody a cross-balanced, centrifugal governor . . . are sensitive without oscillation . . . positive and long lasting. They require no lubrication, and are unaffected by temperature or vibration . . . can be calibrated to RPM, tons per hour, bottles per hour, minutes drying time, sheets per minute — in short, to meet practically every industrial requirement.

Call on us for prompt, complete information on Tachometers. They are available in standard hand types, or can be engineered to meet your special requirements.

No guesswork when you use a Corbin Tachometer.

Corbin Screw Division
American Hardware Corp.
New Britain, Connecticut

PA-2

Accurate CORBIN Tachometers

RAWSON ELECTROSTATIC VOLTMETERS

Type 518

Now available to 35,000 VOLTS
Measure true R.M.S. values on A.C., no waveform or frequency errors.

NO POWER CONSUMPTION
Leakage resistance greater than one million megohms. These meters may be used to measure.

STATIC ELECTRICITY !
Ideal for measuring high voltage power supplies with zero current drain. Rugged, well-damped movement. All elements surrounded by metal shielding for accuracy and safety.

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Interval Timers

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Relays

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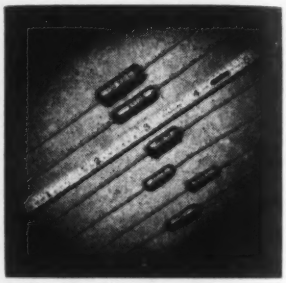
AUTOMATIC ELECTRIC MANUFACTURING CO.
MANKATO, MINNESOTA

of bushings is from 0.243″ OD., 28 thread to ⅜″ OD, 24 thread, class #2 fit. Lengths exclusive of hex head, are 9/32″ to 5/16″ accommodating capacitors from 0.125″ OD to 0.272″ OD. Capacitors range from 5 mmf. to 17,500 mmf. capacity. Manufacturer claims that unusually high capacitance in relation to physical dimensions make new capacitors especially applicable where space is extremely limited.—*Electrical Reactance Corp., Franklinville, N. Y.*

Please mention number 162 when filling out card

Midget Round Capacitors

New "Types ZY and ZZ" line of midget wax-impregnated capacitors are among smallest ever manufactured. Standard "ZY" units are ¾″ long and from 3/16″ to 11/32″

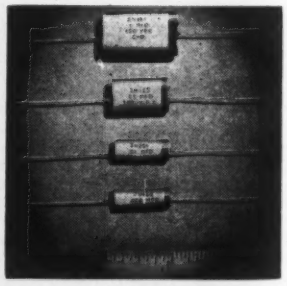


in diameter. Values range from 0.0001 mfd. to 0.006 mfd; d.c. at 600 volts, 0.002 mfd. to 0.02 at 400 volts, 0.004 mfd. to 0.02 mfd. at 200 volts and 0.01 mfd. to 0.05 mfd. at 150 volts. Standard "ZZ" units are ½″ long and from 5/32 to ¼″ in diameter. Values range from 0.0001 mfd. to 0.01 mfd.; 150 volts d.c.—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

Please mention number 163 when filling out card

Midget Flat Capacitors

New "Type ZN" complete line of flat midget capacitors, are said to be ideally adaptable for circuit applications where space is at a premium. They are non-in-

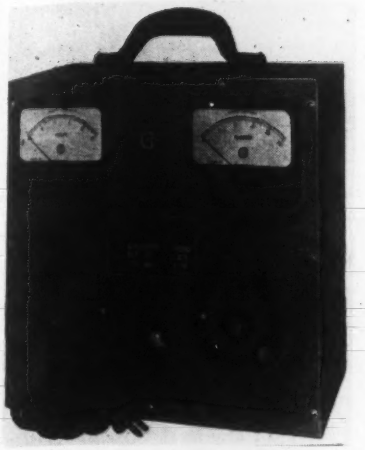


ductively wound with Kraft paper and impregnated with halowax. Leads are securely anchored to capacitor body. "ZN" types include units from ¾″ length, ¼″ width and 3/32″ thickness to 1″ length, ⅝″ width and 3/16″ thickness. Values range from 0.0001 mfd. to 0.1 mfd.; d.c. rated voltages from 150 volts to 600 volts.—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

Please mention number 164 when filling out card

Portable Bench Rectifier

New "Model 725S1-C" portable rectifier unit, claimed to be the first of its type on the market, is a complete d-c. power supply source with a capacity of 150 watts. Cabinet dimensions are 14″ × 14″ × 9″; weight approx. 45 lbs. Output is adjustable from zero to 6 volts and has a continuous capacity of 25 amperes. Among features: Single-phase full-wave circuit, using a quadruple protected selenium rectifier element of practically unlimited life. Unit is convection cooled, has no moving parts and operates

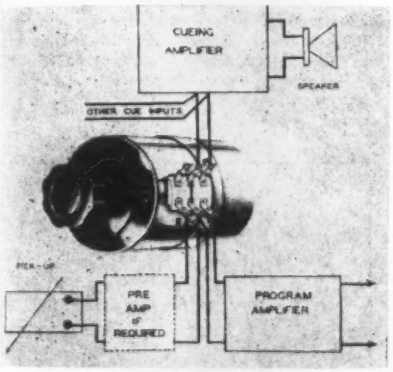


noiselessly. Voltmeter with an accuracy rating of 2% full scale is connected across output terminals and a matching ammeter indicates output current.—*W. Green Electric Company, Inc., 130 Cedar Street, New York City.*

Please mention number 165 when filling out card

Attenuators with Built-in "Cueing Control"

New built-in cueing control is announced for maker's line of attenuators. It serves to transfer program material to a separate cueing amplifier, thus obviating need for

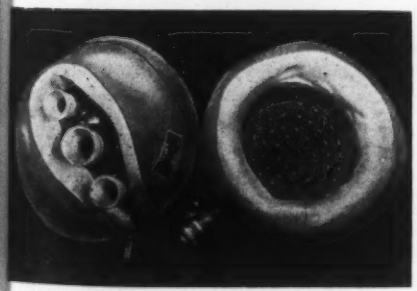


additional switching devices. Provision is made at extreme attenuation position for connecting incoming signal to a cue circuit before "fading in" the signal.—*Daven Company, 191 Central Avenue, Newark 4, N. J.*

Please mention number 166 when filling out card

Flask-heating Jackets

New "Gyco Heating Jackets" for laboratory flasks have an exterior covering of glass cloth impregnated with an aluminum vinyl resin. (Plain glass fabrics formerly used were soiled easily, lacked an effective cleaning method.) Besides being resistant to soiling, new vinyl resin covering withstands most acids and laboratory reagents. Jackets are constructed of highly insulat-



Prompt Shipment on...

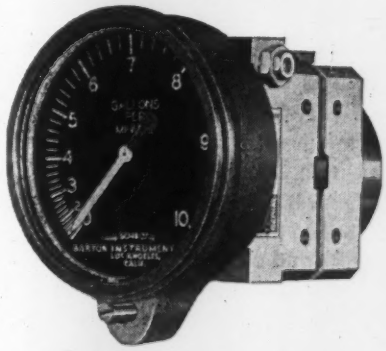
Insulation Testers!

. . . You can get this portable 2500-volt, 0.75 kva capacity portable insulation tester *promptly from stock.* It not only gives you quick, accurate insulation tests, but is a handy device to have for rapid testing of all types of electric apparatus and parts. Size 15 in. x 7 3-4 in. x 8 3-8 in. weighs only 47 lbs. Includes two 15 ft shielded high-voltage leads and 15 ft of cord for plugging into 115 v 60 cy supply. OTHER PORTABLE A-C TESTING EQUIPMENTS NOW AVAILABLE "OFF THE SHELF". Write for Bulletin GEA-4477, *Apparatus Dept., Sec. 401-75, General Electric Co., Schenectady 5, N. Y.*

GENERAL ELECTRIC

401-75-6155

Differential Pressure INDICATOR



FOR RATE OF FLOW AND LIQUID LEVEL MEASUREMENTS

Suitable for Static Pressures Up to 3,000 P.S.I.

HAS RUPTURE-PROOF BELLOWS UNIT

An exclusive feature. Sensitive and accurate under high operating pressures. Withstands extreme over-ranging.

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3500 UNION PACIFIC AVE.
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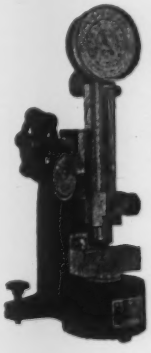
HARDNESS TESTING...

done WITH NO METAL HAZARDS. The SCLEROSCOPE has done it for the past 39 years.



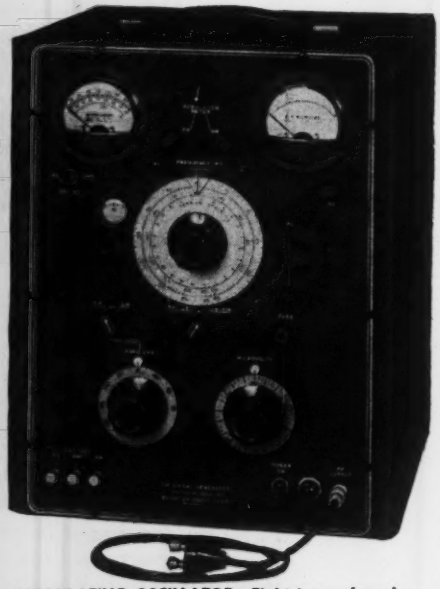
In general use for specification purposes. Simple, sturdy. Comparatively inexpensive.

Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.

9025 Van Wyck Ave., Jamaica 2, N. Y.

NEW!
FM SIGNAL GENERATOR
MODEL 202-B



FREQUENCY RANGE
54 to 216 MEGACYCLES

The model 202-B is specifically designed to meet the needs of television and FM engineers working in the frequency range from 54-216 mc. Following are some of the outstanding features of this instrument:

RF RANGES—54-108, 108-216 mc, ± 0.5% accuracy.
VERNIER DIAL—24:1 gear ratio with main frequency dial.
FREQUENCY DEVIATION RANGES—0-80 kc; 0-240 kc.
AMPLITUDE MODULATION—Continuously variable 0-30%; calibrated at 30% and 50% points.
MODULATING OSCILLATOR—Eight internal modulating frequencies from 50 cycles to 15 kc., available for FM or AM.
RF OUTPUT VOLTAGE—0.2 volt to 0.1 microvolt. Output impedance 26.5 ohms.
FM DISTORTION—Less than 2% at 75 kc deviation.
SPURIOUS RF OUTPUT—All spurious RF voltages 30 db or more below fundamental.

Write for Catalog D

This instrument was described editorially in November ELECTRONICS—reprints available on request

BOONTON RADIO Corporation
BOONTON·N·J·U·S·A
DESIGNERS AND MANUFACTURERS OF
THE Q METER · QX CHECKER
FREQUENCY MODULATED SIGNAL GENERATOR
BEAT FREQUENCY GENERATOR
AND OTHER DIRECT READING INSTRUMENTS

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offers a specialized development and engineering service in
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In the article "Diaphragm Control Valves" by Bruce Irwin, Hammel-Dahl Co., Providence, R. I., appearing in our July, 1948 issue, the definition of the term "equal-percentage" and certain other definitions and related material were quoted from earlier publications of the Mason-Neilan Regulator Company, and credit therefor was inadvertently omitted.

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Editorial

St. Louis Papers Contest

It probably will not often occur that we shall single out one Section for special recognition in this column, but we can think of nothing more fitting when some Section deserves, in our opinion, such recognition. We likewise believe that this is one of those occasions. Therefore, St. Louis becomes the subject of this editorial in return for that Section's consideration for the welfare of the *Journal*.

At the November meeting of the Section, a Papers Contest was announced for the dual purpose of obtaining articles worthy of publication in *The Journal of the I.S.A.* and of expanding member interest and participation in the affairs of the St. Louis Section. All members of the Section in good standing are eligible to participate in the contest, and cash prizes are to be awarded for the best entries. The contest is being conducted under rules set up by the Executive Committee of the St. Louis Section, and will close Feb. 7, 1947.

The membership of the St. Louis Section represents a wide variety of fields of endeavor, including as it does instrument maintenance men, engineers, operators, manufacturers' representatives, and many others. Dr. R. H. Munch, Chairman of the Section (and one of our National Vice-presidents) expects equally as much variety in the type and scope of the papers submitted. It is his intention to submit all papers to us for consideration with respect to their possible inclusion in the *Journal*. Publication will be at our discretion, of course, but the simplicity of the idea itself as a means of getting material makes us wish we had thought of it first—especially when we first took office last September.

We are looking forward with great interest to the papers we expect to receive from St. Louis in another month or two as a result of this contest. And, while not wanting to steal the thunder of this up-and-coming group, we do not hesitate to suggest that other Sections consider the idea too. As we stated in one of our early editorials, the more material we have to choose from, the bigger and better will be the *Journal*. After all, this is *your Journal*, representing *your* Society, and the more you put into it the more you will get out.

Hats off to St. Louis for this much-appreciated forward step.

—RRP

"BY THEIR DEEDS . . ."

A Guest Editorial by

HUGH E. FERGUSON

Many of the leading characters in the Old Testament are referred to as prophets—Ezekiel, Isaiah, Jeremiah, and others. Latter day cynics have explained the power of these men as being due to the fact that, in those tribal days, few persons could visualize such a thing as the future, and fewer still could extrapolate existing conditions into prognostications. Thus, the few men who gave earnest thought and study to the future, successfully formulated reasonable forecasts of future conditions, and made plans for future action, were so exceptional that they were highly respected by their less fortunate brethren.

Whether we accept this cynical explanation of the ability of these ancient prophets, or whether we adhere to the orthodox explanation that they were divinely guided—it is interesting to compare them with the leaders of today. In the pre-Christian era, relatively *few persons tried* to look into the future; now *very few people do not try* to do so. But more significant is the fact that, instead of merely trying to obtain a glimpse of future conditions and making plans in accordance therewith, today thousands of people give study and effort to *altering* and modifying future events and conditions. The prophets or leaders of today are not merely visualizers or seers—they are planners and designers. Through research, engineering, legislation, philosophy—yes, even by war—they are trying to alter and *improve* the future, not merely look at it.

This sermonizing leads up to the exhortation that each and every member of the Instrument Society of America should join the company of the contemporary prophets—to become one of those who try to improve the future rather than merely contemplate it. Don't merely *think* about the future of our Society—*do* something about it. Strengthen the organizations of your local sections, improve the quality of your meetings, help increase the membership, participate in the expansion of technical activities. If you would get any satisfaction from correctly forecasting that in 1948 the Society will have 2,500 members — you should get a lot more satisfaction from realizing in 1948 that the Society had 5,000 members—provided you had been one of the many who helped upset your own forecast.

As Treasurer of the Society, I earnestly solicit your participation in the growth and improvement of the I.S.A. And as Section Chairman for the 1947 Exhibit and Conference, I respectfully request your aid and efforts to insure its being of maximum help and value to technicians and engineers engaged in planning the futures of their industries.

Let's *make the future* of the I.S.A.—not merely try to see it.

EDITOR'S NOTES

1. Who's Who

In this issue we are starting our promised series of "Who's Who in the I.S.A." articles designed to acquaint the members of our Society, as well as the other readers of this magazine, with the men who are responsible for the functioning of the organization. In each issue we intended to publicize at least three men and their activities, and, insofar as possible, each group will include one officer or member of the Executive Committee, one Section delegate and one committee or sub-committee chairman. Of course, since there are only a few officers, this arrangement can be followed for only that many months, after which we will "double up" on delegates or committee chairmen. We hope to conclude the series within a year.

The men selected for this issue are Mr. Hugh E. Ferguson, National Treasurer, Mr. Albert H. Shafer, Pittsburgh Section Delegate, and Mr. Warren F. Haring, Chairman of the 1947 Exhibitors' Advisory Committee.

2. The First Three Months are the Hardest

After three months on the job as Editor pro-tem, we are beginning to get results from our pleas for help. Notice the increased size of this issue! We are now in the position we strove for at first—that of having enough material to work with. In fact, for the first time, we are forced to make decisions as to what material should be used, what can be left out, and what may be postponed till later.

For this very comfortable feeling we wish to offer our sincere thanks to the *Journal* correspondents, secretaries and delegates of the various Sections who have given us their whole-hearted cooperation and have responded so nobly to our many requests. To these gentlemen we would make one more public request—please keep it up! Your efforts are sincerely appreciated.

3. Space Now Being Reserved

We learned just before the deadline on this issue that the invitations to prospective exhibitors at the 1947 Conference and Exhibit in Chicago had gone out late in December. Within a month or so we hope to start reporting the "box score" as the exhibit space is reserved. The Exhibit (and Conference) is to be held in the Stevens Hotel, Chicago, next September 8-12.

4. 1947 Conference Papers

The Papers Committee for the 1947 Conference and Exhibit has one of the most important jobs of all—that of securing papers which will be of the highest caliber and which will attract and interest the greatest number of people. Many potential speakers have been contacted and we are assured of some excellent papers, according to "Jack" Frost, chairman of the committee. However, it is possible that some extremely important subject, paper, or speaker will be overlooked simply because of lack of proper contact. We therefore urge anyone who has such a paper prepared, or can prepare one, or who knows of an eminent speaker who should or can be secured for this Con-

(Continued on page 86)

Instrument Developments in Britain*

By H. B. CRONSHAW

(PART ONE)

I WOULD like to say a few words, first of all, about my impressions of this great meeting that you have called together. It is doubtful if there has ever been an occasion on which so many important papers, covering so wide a field, have been brought together, at a time so significant in the history of instrument technology. The organizers of this conference are to be heartily congratulated for having clearly recognized a need which has arisen out of a unique set of circumstances, and they are to be congratulated for the remarkable way in which they have fulfilled this need.

In the past twenty-five years, I have attended many industrial exhibitions in England and Germany, and in other parts of Europe, but I can honestly say, without the slightest hesitation, that none has come anywhere near this exhibition in Pittsburgh, in sheer beauty and good taste, in interest, presentation, and organization. It is a magnificent achievement and the Instrument Society of America and its associates should feel proud of their work. If I may single anyone out for special recognition, it would seem from the inquiries I have made that we are above all indebted to Mr. Rimbach and Mr. Exline for the energy and time they have devoted to the conception and planning and manifold details of organization which are all too often forgotten when the job is completed.

Not only is this conference the first to be held by the Society, but it is also one which marks the close of a period of restriction in the release of technical information, despite an output on a scale far beyond all precedent.

This week the dampers are thrown wide open and we are almost swept off our feet by the accumulation of years. Virtually, we are being reconditioned for the next push forward and it is, I imagine, with these thoughts in mind that your officers were inspired to signalize this meeting as, "Instrumentation for Tomorrow."

Only yesterday, I came across a good illustration of the state of affairs which exists in the release of technical information. One of the research workers at the Carnegie Institute of Technology told me that before the war he had written eleven papers; during the war he had written none; now he is engaged on thirty papers based on work he has carried out during the years of restriction.

If, as the papers and also the exhibits of this meeting clearly demonstrate, there have been remarkable advances along the entire front of instrument technology in America, one may presume considerable advances in other parts of the world, in Great Britain, Germany, Russia, and elsewhere. Possibly, each worker in his own specialized work knows what these advances have been, but it is doubtful if anyone has made anything like a complete survey of the whole vast field and yet, on the score of economy in time and effort which results from avoidance of overlap, and the more positive stimulus to development which results from new ideas, there is an obvious advantage in having a picture which is complete in every possible detail.

One way of making a broad survey is by means of an international conference, but this might fare no better than most international conferences in the matter of give and take, by which I mean that the tendency is to repeat what is already known, and to withhold most of what is not known. It occurred to me when noting that your program includes a plea by Dr. Müller for an institute of instrument research, that one of the functions of such an organization might well be to act as a clearing house for information, both technical and economic, gathered from all instrument manufacture and user countries of the world, and that a thorough survey made now would provide a foundation of great utility in both economic and technological spheres of the industry, not to mention its value for educational purposes.

However, quite apart from the question of gathering information on progress and conditions in other countries, I must confess that it came as a surprise to learn that the great industry of instrument manufacture in America is still without its national research station. Even in a relatively small and proverbially slow-moving country like Britain, we have had a national center for instrument research for the last twenty-eight years. It has, it is true, always been heavily loaded on the optical side in the interests of the fighting services, but this is now being rectified and steps are being taken to extend its activities over the whole field of instrument technology, largely in response to the demands of industry, but also, no doubt, in conformity with the elaboration of military science.

These considerations lead directly to the particular task which your Secretary has assigned to me. I am afraid, however, that what I have to offer merely illustrates the truth of my remarks on the subject of international conferences. In any case, quite apart from the awkward question of give and take, two further difficulties present themselves.

If it be assumed that you are not particularly interested in anything which Britain has managed to beg, borrow or steal in the last six years or so, I should imagine the best way of tackling the assignment would be to record every departure in design and construction and application from what has been achieved in America during this period of time. This, however, presupposes an intimate knowledge of recent American developments, which I do not possess. In other words, the standard of reference is missing.

There is also another point which I have had to bear in mind. Before leaving England, I was warned that if I said anything about a new instrument, or rather, what appeared to be a new instrument, someone would be sure to jump to his feet and politely inform me that he had been making it for the last twenty-five years! This, in itself, naturally tends to introduce an element of caution into a paper which is supposed to deal with new developments, and for this and the other reason mentioned before, I am going to play for safety by dealing with the subject on the broadest possible lines.

First, a few words about the industry itself; all observations, by the way, are purely personal observations and do not necessarily reflect opinions held in business or official circles.

I think it might be a good thing, right at the beginning, to say something about American instruments. There are no illusions in Britain regarding the formidable size and strength of your industry, and its vigorous and progressive characteristics, nor do we fail to appreciate the very high standard of quality and remarkable ingenuity of those instruments which have found a market in our country. It is a remarkable thing that this penetration has engendered no signs of resentment. What it has done is to induce a spirit of emulation. Firms like Bristol, Brown, Taylor, Bausch and Lomb, which have established themselves in London are highly respected and judging from what I have seen and heard, they have every reason to be well satisfied with the results they have achieved.

On the personal plane, I have everywhere found feelings of warm friendliness and good fellowship among British manufacturers toward their American counterparts. Invariably, they are proud to recall the hospitality they received on visits to America, and I am quite certain they welcome every opportunity to reciprocate.

Of course, there are difficulties at present, as you will appreciate. Only the other day, I met a returned visitor.

*Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Pa., Sept. 16-20, 1946.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of the authors and not those of the Society.

magnificent in a new tweed suit, and he was wondering how he could return the compliment when the Rochester man came to London!

On the business plane, British manufacturers are confident of the future. Let me put it in this way: they are determined to give you a good "round of golf." They may have lost a few holes—perhaps many holes, for all I know—but they are bent on winning them back in the next round, or in the one after that; it doesn't matter, so long as they succeed in the end. That is the sort of game they most enjoy and they know your preference lies in the same direction.

As an illustration of the sort of confidence that prevails, it is interesting to note in connection with the oil industry, which is a big user of American instruments, the chairman at a recent conference on instrumentation was led to remark that there are very few British instruments among the tens of thousands which are in every day use in Britain. There is much to be learned from American instrumentation, he said, and several instrument firms are learning fast—so fast, in fact, that he believed they would soon take the lead in this field.

If this is taken as a measure of the optimism which has entered where there appeared to be least grounds for hope, one may, I think, assume that other departments of the industry are at least equally confident about the future.

As regards the broader field of industrial control instruments, in which you have always occupied a dominating position, an interesting remark was recently made by a speaker at a conference. It was, he said, a sobering fact that among industrial instruments there were few in regular production which were not either a direct copy or a development of an original American design, and he complained that we have relied too much on American practice and design. Nevertheless, being a manufacturer, he was careful to put the blame on the users, who, he said, give little encouragement to the British manufacturer to develop designs for specific applications. Possibly, other manufacturers would not be prepared to go as far as this speaker did, but there can be no doubt that the industrial application of control instruments has been more readily taken up in America.

I have raised this point with manufacturers, only to be reminded that in 1895 Callender made the first self-balancing recording potentiometer ever made and that there is plenty of other proof that British instrumentarians—if you will permit me to use the term—are not without inventive ability. Moreover, I am told, there is a lot in the bag that has still to come out, when official restrictions are fully relaxed.

Let us see what justification there is for these hopes. I do not propose to make any detailed analysis, but will merely give you the main trends. In order, however, to bring these into true perspective, it will first be necessary to sketch in the general background against which they should be viewed.

History has clearly demonstrated the interplay between scientific discovery and instrument development. For example, the modern spectrograph goes back to Newton's experiment in 1666, when he made a small hole in the shutters of his room in Trinity College, Cambridge, interposed a "triangular glass prism to try therewith the celebrated phenomena of colors," and obtained a spectrum on the opposite wall.

Nearly 250 years later, at almost the same spot, Lawrence Bragg used the modern version of Newton's instrument to explore the innermost structure of crystalline bodies.

This is only one example out of hundreds which go to establish the fact that new developments in instruments make possible, and therefore foreshadow, new advances in knowledge, and these, in turn, lead to new instruments for improvement of existing designs.

Consequently, one of the most important features of the background is the present and probable future structure of the country's research. Under the stress of two wars, the structure that has evolved may be said to be national in character, aimed very largely at promoting the country's industrial efficiency. Now, under the circumstances in which we find ourselves, its shortcomings have become all too obvious and preparations are being made for a great expansion and intensification.

Looking back over the last fifty years, it is hard to realize that right up to the first war, in 1914, the National Physical Laboratory represented practically the entire effort of the state to provide scientific aid to industry. It was not until 1900, when the Laboratory was founded, that the dependence of modern industry on accurate measurements and accurate knowledge of materials was first clearly recognized. It is true that long before this, the need was seen by a few, but they were only a few. Lord Kelvin was one, and he lived well up to his precepts that true physical knowledge can only be based on accurate measurements, and that one must obtain a measurement, however rough, and then endeavor to get a better.

In fact, there is little to dispute in the claim that Kelvin was the first of our scientific instrument makers, and when he swept out the old wine cellar at Glasgow University and laid on the water, he gave us our first physical laboratory. That was in 1846—exactly one hundred years ago.

I have said, "*our* first physical laboratory" but that is not strictly correct, because it was located in Scotland. Another quarter of a century had to pass before the English realized they had no laboratory, and in 1871, the Cavendish Laboratory was founded at Cambridge University. Maxwell was followed by Rayleigh, and then by Thomson. Later came Rutherford, and now Bragg.

However, Maxwell, Rayleigh and Thomson had little practical sense of instruments. They were essentially mathematicians, and theorists, and their work in these spheres is well known to you. In Maxwell's day, the only instrument for measuring electric currents was the human galvanometer, and it was the special privilege of visitors to perform this test by dipping their hands into two bowls of water containing the terminals, and recording the intensity of the shock which measured the current.

Rayleigh was no devotee of the instrument maker. He probably instituted the tradition of "glass, sealing wax and string," which became characteristic of the laboratory, but as a close student of acoustics, he did complain, on one occasion, that the laboratory possessed no musical instrument! Incidentally, this throws some light on the custom, which still persists, of coupling the word "scientific" to "instruments," whether academic or commercial varieties, presumably as a means of distinguishing them from musical instruments.

Rayleigh's best known work was on the standardization of the ohm, and the spinning coil he used is still in the laboratory.

J. J. Thomson's experimental tool

The author, Dr. Cronshaw, until recently a resident of London, England, was graduated in mining metallurgy from the Royal School of Mines, London. After serving for the next two years as an oil geologist in Trinidad, he returned to his studies for four more years, specializing in chemical research and mineralogy at the Universities of Cambridge (B.A.) and Munich (Ph.D.).

Later investigations included performance of furnaces in industrial England (Carnegie Scholarship), and genesis of tin ores and coal deposits, as well as some geophysical work. He was appointed Professor of Geology and Mineralogy at the National University of Ireland and, 7 years later, Director of Research and Technical Education at Birmingham.

For the last 20 years Dr. Cronshaw has been engaged in London in consulting work and as editor of chemical, food and other technical journals. Recently he pioneered the Society of Instrument Technology in Britain, and served as chairman of a Standardization Committee for dairy equipment.

Dr. Cronshaw and his family recently took up residence in Los Angeles, California, where he expects to continue his pioneering work in technical writing and publishing.

was mathematics rather than material apparatus. One of his assistants said, "J. J. was very awkward with his fingers and I found it necessary to encourage him to handle the instruments," and yet, his understanding of the irresponsibility of the instruments then used was almost uncanny. When the exasperating vagaries of the apparatus had reduced everybody to baffled dispair, along would shuffle this remarkable man, who, after cogitating at his funny old desk in the corner, and jotting down a few figures and formulae on the back of an envelope, or the laboratory checkbook, would present a solution like a rabbit out of a hat. "This intuitive ability to comprehend the inner workings of intricate apparatus without the trouble of handling it," remarks Aston, one of his colleagues, "appeared to me then, and still appears to me now, as something verging on the miraculous, the mark of great genius. I might add that G. P. Thomson, the son of J. J., is at the present time the President of the Society of Instrument Technology.

There is no need for me to recall to you the brilliant work of Rutherford in radio-activity and atomic disintegration, taking as his starting point, in about 1900, the discoveries of Becquerel and Curie, nor the work of the two Braggs, father and son, in the field of x-ray crystallography, commencing about 1929. The younger Bragg is now continuing this work at the Cavendish Laboratory.

About the time Rutherford began his researches the National Physical Laboratory was opened by King George V, in 1902, with these prophetic words: "I believe that in the National Physical Laboratory, we have the first instance of the state taking part in scientific research. Does it not show in a very practical way that the nation is beginning to recognize that if her commercial supremacy is to be maintained, greater facilities must be given for furthering the application of science to commerce and manufacture?"

Certainly, the nation was beginning to recognize the significance of industrial research, but it has taken 44 years and two wars to grasp the full significance of King George's words.

In Germany, there was nothing like the same lag. State fostering of science, with an eye on industrial development, was not regarded as government interference, and did not meet with resistance from the exponents of free enterprise, at any rate, not to the same extent. The average Britisher could see little connection between test-tubes and a good dividend. Industrial supremacy had been built up in quite a different way, certainly not by government meddling with private business. It had been built up by sturdy independence and free enterprise. The feeling was "Let the best man win."

On the other hand, technological institutes spread through Germany and university departments worked with industry; research was cultivated and organized in the national interest. There seems little doubt that had we plunged into a full program of industrial research, there would have been little to temp the Germans to embark on the adventure of 1914. Perhaps there is a moral in this which also applies to present conditions.

That was the attitude in 1914. The war came and it revealed the extent to which Britain had become dependent on Germany for supplies of chemicals, optical glass, laboratory glassware, instruments, and so forth. It also demonstrated the practical advantages the Germans were deriving from organized research. There was no alternative but to do likewise, and in 1916 a special government department was set up under the title of the "Department of Scientific and Industrial Research."

The problem in designing the scheme was how to organize research for the benefit of industry, and also the community, without creating any suspicion of interference. A large expansion of research had to be achieved with active, full cooperation, but without creating any suspicion of compulsion or officialdom. The government's scheme for industrial research that was evolved after much careful thought is remarkable, not only in harmonizing these competing aims, but in actually encouraging a spirit of independence and initiative.

Briefly, the framework consists of two structures, an inner and an outer. The core is a group of ten research stations, devoted to research undertaken in the interests of community and government. These are under the direct control of the Department and embrace a number of departments of research which I need not name, such as building, fuel, food storage, and so on.

The outer structure is a flexible framework for the accommodation of research associations. These are autonomous bodies set up by the industries themselves, with financial assistance from the government. The first to be set up was the British Scientific Instruments Research Association, in 1918. At present, they number about thirty-two associations, covering, for example, the paper, silk, canning, pottery, and flour milling industries, and so on. Future expansion will probably be largely in engineering subjects.

During the past few years it has become increasingly clear that industrial research must be greatly expanded if we are to hold our own under the stress of competition. The matter has been discussed and publicized at all levels, from Parliament downward, and there has been—and still is—constant reiteration of the urgent need for an all-out drive in industrial research, coupled with productive efficiency, aimed at the expansion of old industries and the creation of new ones.

"Only in this manner," concludes the Federation of British Industries, "shall we be able to increase the production of wealth, without which it will not be possible to maintain—let alone improve—the standard of living in this country." Now, every industrial concern is being urged to make the greatest possible use of scientific knowledge directly it becomes available, to make the fullest use of its research association, to establish its own research department, and to give active support to the training of technical personnel.

Perhaps the most urgent problem is the supply of scientific man power upon which the government has just issued a report. It seems that we are threatened with a famine, unless the present output can be quickly doubled. What we need immediately is 5,000 fully qualified scientists per year.

As for the government's attitude, this is presumably contained in the words of Mr. Morrison, President of the Council, who says, "Scientific research has and will continue to have the full support and encouragement of the government. This is a scientifically-minded government. This government is using experts and will always use experts from every branch of science, not only in the formation of policy, but in carrying out the decisions, once they are made. This government will do everything possible to encourage British industry to use scientific research."

After allowing for "political license," this is probably a true representation of the government's intentions. So much for the general background.

But what of the intrument industry as viewed against this background? Why the general feeling of optimism which pervades the industry as regards its prospects for the immediate future? Again, here, I shall make no attempt at a close analysis, but will merely sketch in some features that appear to indicate a substantial basis for this optimism.

It is obvious that the key for any broad scheme of industrial research should be a research station for instruments and instrumentation. The British Scientific Instrument Research Association, under the direction of A. J. Philpott, is, in fact, the oldest of the research associations, but it is not yet representative of the instrument industry as a whole, though it shortly will be. This is because the Association has always been closely linked with the services and its work has therefore been largely restricted to problems in the optical field. This work was of the utmost value during the war, notably in the development of lead sulphide reticules, the photo-etching reticule process, the volatilized aluminum and rhodium mirrors, the blooming process, color filters, and various optical cements and anti-rain compounds, and so on.

Lately, firms representing most other sections of the instrument industry have joined the association, and for this reason, and because it is now clearly recognized that the association

ust play a vital part in the program industrial research which lies ahead, e scope of work is being enlarged to mbrace practically the entire field of strument research. A new building w under construction should provide mple facilities for this purpose.

I might also mention at this point, d I will refer to it later, the found- g of a new department at the Na- nal Physical Laboratory for the udy of servomechanisms and systems automatic control. This is an inter- ting and important development be- use it will attack the problems of tomatic control from a fundamental andpoint. That is to say, research orkers who are pure physicists will oroughly analyze by physical and athematical methods the various sys- ms of control that are possible.

Now a word on technology. Between esearch and industry stands technol- gy. The three are closely interlocked, nd inter-departmental. In Britain, any people are still not clear on the eaning of technology. Often, it is aken to be a fancy name for applied cience, in the sense of applied chem- try, physics, geology, and so on. This, owever, is not its true meaning, which s science applied to industry or other ractical purposes. The difference lies in the fact that the technologist recog- nizes no boundaries between the ciences, but freely utilizes what each as to offer toward the attainment of ptimum production efficiency and the olution of specific technical problems. echnology involves research, but the wo are conveniently separated, as echnology is primarily concerned with electively assembling the products of esearch and applying them, in the cientific fashion, to the solution of echnical problems. Instrument tech- nology embraces the entire field of de- ign, construction, management, and se of instruments.

Owing to the fact that the industry ends to be split up into a number of more or less specialized groups which have gravitated toward the different classes of users they serve—such as iron and steel, petroleum refining, boiler and power house engineering, meteorological, medical, navigational and so on—instrument technologists have tended to lose touch with one an- other, and their contributions to in- strument technology are to be found, after much troublesome searching, in the journals and proceedings of me- chanical engineers, electrical engi- neers, and chemical engineers, as well as in others devoted to physics, medi- cine, astronomy, geology, and so on.

This is all to the good of the sub- jects concerned, but it is not as good as it might be for instrument technol- ogy were these contributions central- ized, so as to insure that they are brought to the notice of all workers in the instrument industry.

Fortunately, in America, and indeed for the rest of the world, including Britain, you have your journal *Instruments* which performs this function with remarkable success, within the limits imposed on all technical publications. By this I mean that something more is needed to weld instrument technologists into the live, corporate body essential both to material progress and to the possession of self-respect and professional pride; not that I attach much importance to these latter qualities in themselves, but they are undoubtedly stimulants to personal effort, and they also tend to attract good men into the industry.

This something which is needed to overcome the lack of coherence that has long handicapped the industry, is, of course, personal contact. Again, fortunately, the remedy has lately been applied, first in Australia in 1943, by the formation of the Australian Society of Instrument Technology; then in Britain by the Society of Instrument Technology in May, 1944, and in the United States by the Instrument Society of America in April, 1945. Each of these three bodies provides a focal point, a clearing house, or rallying point—call it what you will—for all the component parts of the industry, so far as its technology is concerned.

These were the considerations which led L. B. Lambert and myself to take the initial steps about three years ago in founding the Society of Instrument Technology, and I am very pleased to report that already the membership is well over six hundred; as a matter of fact, I understand that it is now about seven hundred. The fact that the majority of founder members were users is not without its significance. I understand that the same applies here.

Local sections, one in Scotland, have been formed, and committees to deal with education, nomenclature, and so on, have been set up. As already remarked, the President is Sir George Thomson, a leading exponent of nuclear physics, and scientific adviser to the Air Ministry during the war.

I venture to suggest that a further step in the interests of instrument technology would be made if contact were established between our respective societies. Possibly, they might begin by exchanging papers, say, with written contributions from both sides, and at some future date it might be possible to arrange for joint conventions.

However, as you know, tradition is apt to linger in Britain, and now and again relics of the past are brought to the surface. They are of no particular consequence, except when there is authority behind them. For instance, the other day, a famous engineer made the following remark in the course of a presidential address: "I have learned," he said, "how fatefully easy it is to be misled or become a slave to one's instrumentation. Again and again I have found that it has taken far longer to get thoroughly acquainted with a new research instrument than to carry out research without it, although this does not apply so much to home-made equipment."

Fortunately, the majority of engineers today are in no doubt about the fact that, fundamentally, physics and engineering are one and the same subject, and there is no engineering problem which cannot be broken down into its physical components. Such being the case, modern instruments of high precision are essential to the scientific solution of many engineering problems.

It is plain to see that physics has already made great advances into the domain of engineering, just as it has penetrated far into the field of chemistry. Even in the boiler house, mechanical stress is determined by electrical strain gages and by x-ray diffraction.

I should like to give another quotation to illustrate the need for applying a correction to distorted views which are occasionally expressed at public meetings. It is as follows:

"An elaborately equipped laboratory in the hands of unskilled workers is a fertile breeding ground of fallacious theories. Let the money be spent on the production of skilled workers rather than on magnificent equipment. I have not been much impressed by what I have seen in these laboratories abroad. The array of equipment is imposing indeed, but it must be more than a life's work for even a highly skilled staff to learn properly how to handle all that equipment, much less make any good use of it. In practice, the bulk of it remains as pure window dressing."

That statement was made by a president of a society—an engineering society. It is evident that the speaker does not appreciate the difference between elaborate, clumsy apparatus of the home-made variety, which can sometimes only be understood and operated by those who have made it, and the robust, commercial instruments designed for speed, accuracy, and simplicity of operation, which are also fool-proof.

Callender used to tell his students, when they had built their research apparatus and had learned all its idiosyncrasies, "Now go and buy one." You may be certain that taught them a lot more.

Two years ago, ninety-two scientists and industrialists signed a statement at Oxford to the effect that much more can be fruitfully spent in providing research workers with more adequate equipment; and only last year, a strong complaint was made by a professor regarding the antiquated instruments which students have to work with in universities.

Much is being done and will continue to be done by the Society of Instrument Technology in guiding the training of instrument technologists along the right channels and also in bringing about a closer association between universities and industry. There is still much to be done in orientating the attitude of physicists toward industry

generally and toward the instrument industry in particular. We need more engineer-physicists of the Cockcroft type. J. D. Cockcroft, formerly with Rutherford at the Cavendish Laboratory, and now Director of the Atomic Energy Station, began his career with Metropolitan Vickers and graduated in electrical engineering at Manchester before he took the highest honors in mathematics at Cambridge. The influence of Cockcroft in British physics, and hence on the instrument industry, is certain to be highly beneficial in the years to come.

It is beginning to dawn on many users that there is not much point in putting instruments into industry if nobody knows how to use them. It pays to employ a competent technologist to select, install and manage the instrumentation. It is sometimes said that the average user does not know what he wants, and often the manufacturer does not either. Bringing the user and the manufacturer together is thus an important function of the Society. There are still people who show more faith than understanding in their belief that instruments always show the correct results, even when they are used as a convenient support for one end of a ladder.

Personal contact is a powerful stimulus to thought and effort. Meetings and joint meetings are the most effective way of bringing together not only members of one technological group, representing users, manufacturers, and scientists, but also members of different groups. In this way, channels of communication are opened up for the flow of ideas and information, which is vital to progress and essential to industry. Meetings enable questions to be asked and replies to be given from more than one viewpoint. If papers are well chosen, the discussion is apt to bring to light some useful points which might otherwise lie hidden for years. It is unfortunate that discussions are not always published in full, nor submitted for written contributions, and there is often considerable lag in publication.

During the war, it was often difficult to assure good contact when men with ideas were trying to introduce new devices and new methods into the Armed Forces. In the early stages, contacts were very bad, but later they did improve. The Germans never seemed able to solve the problem, and perhaps it is as well for us that they did not do so.

In Britain, we recently had one of these joint meetings between the Society of Instrument Technology and the Society of Dairy Technology. The subject was the instrumentation of high-temperature short-time (H.T.S.T.) milk-pasteurizing plants, a particularly difficult problem for the instrument man, as well as for the dairy man, because of the narrow limits of time and temperature imposed by (1) official regulations — namely, not less than 160°F. for not less than fifteen seconds, and by (2) the consumer— because of the damage to taste and cream line when an approximation of the official time and temperature is exceeded.

Time permits only a brief reference to a number of important points brought out by this joint meeting. For instance, lag, response, and sensitivity are obviously important matters in the H.T.S.T. system. At first, American instruments were largely used, but owing to the more exacting British requirements, an investigation was started at the National Physical Laboratory which resulted in valuable fundamental data. At the joint meeting to which I am referring, these data were given as well as information concerning a new type of thermometer devised by joint research between technologists of an instrument firm and a firm manufacturing H.T.S.T. plants.

Argument moved from relative merits of these two types of instrument on to a more general plane. One minute people were calling for absolute accuracy; the next, they were demanding rugged robustness. One speaker said he had often cursed manufacturers for lack of robustness in their instruments. "I have even," he said, "had instruments break down on me during an official opening, which was a bit awkward until we found a piece of copper wire."

Dairy men want their instruments to bounce off the floor like a rubber ball, having apparently heard that millionaires used to assemble in Central Park, New York City, every Friday for a game of pitch and toss with their gold watches. One manufacturer did, in fact, mention that he gives instruments a seven-foot drop test with a three and one-half pound weight tied on, and if they come through they are guaranteed for two years, although actually, a seven year life is assured on the assumption that they are dropped twice a day!

To be continued

EDITOR'S NOTES

(Continued from page 81)

ference, to get in touch with Mr. Frost as soon as possible. The address—H. C. Frost, c/o Corn Products Refining Co., Chemical Division, Argo, Illinois.

5. PHILADELPHIA IN 1948

According to the minutes of the meeting of the Board of Directors held in New York, December 4, 1946, Philadelphia will be the site of the 1948 Conference and Exhibit. Invitations had been received from the Philadelphia, Washington and New York Sections, and the selection of Philadelphia was made on the basis of space available at that time. Further details will be reported in subsequent issues of the *Journal*.

6. THE NEEDLE POINTS TO—

Detroit—for a most excellent job of reporting with respect to completeness and interest.

Baltimore and New Jersey—for program ideas.

St. Louis—for the most complete abstract of a paper presented before the Section, and also for the greatest assistance to the Editor (Papers Contest).

—R. R. PROCTOR

General News

ACTIVITIES OF 1947 EXHIBITORS' ADVISORY COMMITTEE

By W. F. Haring

Toward the close of the "Instrumentation for Tomorrow" conference in Pittsburgh, the exhibitors who participated in this conference formed what is now known as the Exhibitors' Advisory Committee to the I.S.A. This Committee is essentially advisory in capacity to the Exhibit Committee of the I.S.A. Its purpose is to work for the best interests of the exhibitors and to promote the well being of the I.S.A. as a whole. The following representatives comprise the Exhibitors' Advisory Committee:

A. B. Cloud, American Meter Co., New York and Chicago.
Charles W. Downs, Exhibit Section, General Electric Co., Schenectady.
M. P. Odell, Brush Development Company, Cleveland.
Roy F. Coleman, Equipoise Controls, New York.
Warren F. Haring, Wallace & Tiernan Products, Inc., Newark, N. J., Chairman.
Charles Thompson, Moore Products, Philadelphia, Pa.
N. W. Hartz, Mine Safety Appliances Co., Pittsburgh, Pa.
H. B. Randall, Connecticut Telephone & Electric, Connecticut.
Walter J. Halpern, Gotham Instrument Co., 149 Wooster St., N.Y.C.
Wm. Waterman, Waterman Products Co., Inc., Philadelphia 25, Pa.
Joseph Bloom, Waldes Kohinoor, Inc., Long Island City 1, N. Y.
J. S. Louden, Superior Electric Co., Bristol, Conn.
Lyle E. Elge, Fisher Governor Co., Marshalltown, Iowa.

At the meeting held on Friday, September 20, several resolutions were made and approved for submission to the Exhibit Committee relative to the operation of the 1947 Exhibit in Chicago.

Although meetings cannot be conveniently held except during the week of the convention, all matters are handled by correspondence through the Chairman where ideas are consolidated and passed on to the Exhibit Committee as recommendations.

The Exhibitors' Advisory Committee solicits all possible suggestions and recommendations as to ways and means of improving the 1947 show and will make every effort to have as many public services available as are economically and physically possible for the use of the exhibitors as well as the public in connection with the 1947 show. Suggestions for a slogan to be used in boosting the attendance of the 1947 show are especially solicited.

THREE MORE SECTIONS SOON?

The Indianapolis Technical Instrument Society has voted to apply for Section status in the I.S.A. very shortly, according to Morris Underwood, Secretary-Treasurer of that group.

Louisville, Ky., should shortly be represented in the Section roster, reports Eugene H. C. Brown, President pro-tem of a newly

organized group of 84 instrument-minded men in that city.

Cincinnati has been stirring lately, says H. W. Haskett, and it is possible that a group from that city will petition for Section membership before long.

Memorandum Report From Recommended Practices Committee

By F. H. Trapnell, Chairman
(Presented at Executive Committee meeting December 4, 1946)

1. At this time it is not possible to report any specific accomplishments of this committee as it is still in the process of being organized, and planning has not yet gone beyond the stage of discussion as to means of proceedure.

2. Manometer Tables prepared by Hugh E. Ferguson are now being printed in sufficent quantity to submit to various interested parties for preview and comments before being submitted in complete form.

3. Suggestions are requested . . . as to qualified and interested persons to review these tables.

4. A number of new appointments to the committee have been agreed upon . . . and it is requested that an official roster of the committee now be prepared and circulated among the various appointees . . . The committee could well have some additional members and recommendations are herewith requested.

5. Briefly, it is planned to draw from this main committee the men to be chairmen of various sub-committees. Certain members of the main committee will be called upon to review and comment on work done by such sub-committees. Every effort will be made to limit the scope of work required in each separate project so that such work can be completed and submitted in the shortest possible time.

6. The Executive Committee is requested to (through its publicity channels) *ask I.S.A. members to recommend to this committee projects to be undertaken.*

(Ed. Note: Point 6 is emphasized be-it is a direct appeal to all members—the *Journal* being the publicity channel selected for this first report.)

News of Sections

BALTIMORE

At the regular meeting of the Baltimore Section on Friday, Dec. 6, Mr. Franklyn D. Ragan, of the Fuel Department of Bethlehem Steel Co., Sparrows Point, Md., gave a very interesting lecture on "Steel Plant Instrumentation." His lecture was illustrated by slides and covered complete instrumentation of Bethlehem's open hearth furnaces and coke ovens. Mr. Ragan also explained a very interesting control system which is used to control gas flow and calorific value of the gas supplied to Baltimore by the Bethlehem Steel Co. A very interesting discussion period followed Mr. Ragan's talk.

President J. F. Maienshein announced the beginning of an educational program to be sponsored by our own members. These experts will present short papers on the Theory of Instrumentation and Automatic Control. Two papers will be read and discussed at each of the monthly meetings before the main speaker of the meeting is presented.

Mr. Maienshein launched the program with a very interesting talk on graphical methods of adjusting automatic controllers. "Optimum Control Setting Graphs" were distributed to all members, and a very lively discussion period followed.

On Friday, January 3, 1947, a buffet supper will be held at the Baltimore Engineers' Club, followed by a lecture on Gas Analysis by Mr. C. E. Davis of the Davis Emergency Equipment Company of Newark, N. J.

—Kenneth R. Miller, *Publicity Chmn.*

CHARLESTON

Names of new officers of the Charleston Section were announced at the regular monthly meeting, December 2, at the Kanawha Hotel. E. I. Thomas, chief teller of the election, announced that the following men had been elected to office: President, M. B. Lorig; Vice-President, L. F. Keppler; Treasurer, J. K. Corrie; Secretary, C. Cavender; Executive Committee, K. F. Wince and R. Moses.

Retiring officers for the Section who stepped down in favor of their successors were C. B. Cochran, Earl Bryant, Ammi H. Adler, and M. B. Lorig.

Following announcement of the returns, Mr. Walter P. Wills, research director for the Brown Instrument Company, gave an interesting talk on "Field Servicing of Electronic Instruments."

Mr. Wills first explained basic circuit theory, then demonstrated his recommended method of servicing a faulty instrument.

On Monday, January 6, the new year will be set off on a good start with a talk by a representative of the Foxboro Company. The subject will be "Selection and Operation of Air-Operated Control Instruments." There will be a demonstration of the Foxboro Model 40 controller.

On Monday, February 3, a representative of the Leeds & Northrup Company will discuss "Application and Fundamentals of pH and Conductivity Measurements."

—Allyn R. Phillips, *Corr.*

CHICAGO

At the December 2nd meeting of the Chicago Section, held at the Builders Club, approximately 100 members and guests heard Mr. Albert H. Shafer of the Fozboro Company (Pittsburgh Branch Manager) discuss "New Developments in Automatic Control Instruments."

Mr. Shafer went back to the early 1900's, the year of development of the first pneumatic controller, and took the audience from there through the evolution of automatic control up to the latest designs of today.

One of the interesting things brought out was that the early pneumatic controllers were vacuum operated, and that this feature was supposed to have many advantages over pressure operation. It was pointed out as well that the latest controllers have adjustable throttling, adjustable automatic reset and derivative response. Also available is a 4-way air transfer switch which permits much flexibility of operation and allows the instrument to be completely removed from the panel without disturbing the operator's means of remotely controlling the process.

It was announced at the meeting that the Chicago Section had appointed a new Executive Secretary, Mr. Floyd E. Ertsman. The new office address of the Section is 3538 South Wabash Ave., Chicago.

The January 6th meeting, also at the Builders Club, will feature Dr. Truman Kohman, of the Institute for Nuclear Studies, University of Chicago, who will speak on "Measurement and Applications of Radioactivity."

On Monday, February 3, the technical part of the meeting will consist of a panel session, featuring four or five speakers, each of whom will discuss a particular instrument problem or application and its solution or results. The meeting will be held at the Builders Club, 228 No. LaSalle St., with dinner at 6:30 p. m. and the meeting at 7:45.

—John C. Vaaler, *Corr.*

CUMBERLAND

The Cumberland Section held its November dinner and technical meeting on Tuesday, the 26th, at the Queen City Hotel.

The speaker for the technical meeting was Dr. Elden D. Haller, Eastern representative and Field Chemical Engineer for the Beckman Instrument Division of the National Technical Laboratories. Dr. Haller gave a very interesting talk on "Hydrogen Ion Measurement."

The next meeting will be held December 20. Mr. Chas. Packard, Chief Engineer of Struthers-Dunn Company, Philadelphia, will speak on "The Relay as an Instrument Auxiliary."

—H. E. Bishop, *Publicity Chmn.*

DETROIT

The November meeting of the Detroit Section featured a talk given by Mr. A. P. Gifford of the Consolidated Engineering Company, Pasadena, on the subject of the Mass Spectrometer. This instrument analyzes complex gas mixtures, in remarkably short time, by segregating previously ionized particles according to their mass.

The speaker pointed out that the spectrometer was another of those instruments whose basic working principle was discovered decades ago but did not find any important application until the beginning of the war. Among the uses mentioned were the analysis of organic compounds, the study of molecular bond strength, the kinetics of chemical reactions studied during the actual process, and biochemical studies involving isotope tracing.

The audience included many members of other technical groups, such as the American Chemical Society, the Canadian Chemical Institute and the Association of Analytical Chemists who participated in a lively question and discussion period following the lecture.

For the monthly equipment exhibit, the Commercial Research Laboratories of Detroit set up an interesting working demonstration of their flow meters for fuel and air flow.

On Monday, December 16, the Detroit Section will hear Mr. Donald T. Street of Bausch & Lomb Optical Company, who will speak on "Optical Instruments in Industry." This meeting will be the last to be held at the Ethyl Research Laboratory, and at the conclusion of the meeting member Emil Gillig will conduct the group through the Dynamometer Laboratory and through the Instruments and Electronics Section. The Carson Electronic Micrometer will be demonstrated at this meeting.

The January 27th meeting will be held in the Junior Room of the Horace H. Rackham Building. The speaker will be Mr. T. A. Cohen, of the Taco-West Corporation, and his subject will be "Pyrometry."

Future meetings of the Detroit Section will be held in the Horace H. Rackham Building, and the regular meeting night has been changed from the third to the fourth Monday of each month.

—Siegmund Kulka, *Corr.*

KANSAS CITY

At the November 25th meeting of the Kansas City Section, President Bob Cooke (Westinghouse Electric Corp.) welcomed the I.R.E. visitors, for whom this was a joint meeting by invitation.

The speaker of the evening was Mr. Lawrence F. Parachini of the Weston Electrical Instrument Corporation, Newark, N. J., who spoke on "Electrical Indicating Instruments." The talk was basic, technical and most interesting, covering the six basic meter mechanisms in general use and the various accessories used with them to indicate speed, temperature, a.c. and d.c. quantities, etc. Transparent cased models of the mechanisms under discussion were available for inspection.

At this meeting a nominating committee was selected to prepare a slate of candidates for the 1947 offices. The nominating committee, consisting of Messrs. J. M. Pugh and R. J. Hunter of the Standard Oil Company, and G. H. Burke of the Burke Engineering Company, submitted a slate of candidates and announced that the winners of the election would be declared at the next meeting.

At the December 17th meeting the nominating committee announced the outcome of the 1947 election as follows:

President: R. B. Cooke, Westinghouse Electric Company
Vice-President: O. L. Boutros, Boutros Instrument Laboratory
Secretary and Treasurer: R. L. Lewis, Economy Equipment Company.

After the usual backslapping, Mr. Cooke announced that W. A. Reichow of the Minneapolis-Honeywell Regulator Company would be chairman of the membership committee and that prizes would be awarded

Who's Who in the I. S. A.

HUGH E. FERGUSON, *Treasurer*

Our genial Treasurer and guest editorialist for this issue was born in South Boston, Massachusetts on March 5, 1896; he graduated from St. John's Prep, Danvers, Massachusetts, in 1913 and received his B. S. in Chemistry from Catholic University of America, D. C., in 1917. During World War I he was in the Chemical Warfare Service, assigned to the Research Division, at American University, Washington, D. C.

Mr. Ferguson was employed in 1920 as a Chemist by The Peoples Gas Light and Coke Company of Chicago, Illinois—and in 26 years of service with that company has risen to Plant Testing Engineer, in charge of a department entrusted with investigations related to the efficiency and economy of gas production and distribution.

He participated in early organizing meetings, but did not join the Chicago Society for Measurement and Control until after its organization, in 1940. In 1940 and 1941 he served on the Housing and Constitution Committees of the Chicago group. From 1942 to 1945 he successively held the offices of Treasurer, Vice-President, and President of the Chicago society. During his term as President Mr. Ferguson was one of the leaders in the organizing of the various individual groups into the present national society. Serving as Chairman of the Finance Committee during the organization period, he was elected the first National Treasurer of the I.S.A. in September 1946. At present he is Section Chairman for the 1947 Exhibit and Conference to be held in Chicago next September, and is also a member of the Recommended Practices Committee.

Hugh, or "Fergy" as he is called by most of his associates, has also been active in other technical organizations, serving as Chairman of the Fuels, Gas and Combustion Section of the Western Society of Engineers—and is at present a member of the Gas Production Research Committee and the Purging Practices Committee of the American Gas Association. He is the author of a number of papers and studies pertaining to the gas industry, presented before various organizations and published in technical journals.

Hugh is married and has two boys who "frequently give him lessons in how to catch pike and bass."

ALBERT H. SHAFER, *Delegate*
(Pittsburgh)

Albert H. Shafer has been actively associated with the Pittsburgh Section of the Instrument Society of America from the time of its formation and has represented it as a delegate at all organizational meetings of the National Society. He was also an active member of the preceding American Society for Measurement and Control from the time of its inception. He has been chairman of the Constitution Committee of both for several years.

Mr. Shafer is also a member of the ASME and serves on the application committee of the Industrial Instruments and Regulators Division.

He attended elementary school in Chicago Heights, Illinois. From 1917 to 1921 he attended Carnegie Institute of Technology in Pittsburgh and also worked as draftsman for Westinghouse Electric and Manufacturing Company at East Pittsburgh, The Koppers Company, Pittsburgh, and as draftsman and Structural Engineer with the Pittsburgh Construction Company.

In 1921 Mr. Shafer became associated with the Foxboro Company as Sales Engineer and in 1929 was appointed to his present position of Branch Manager.

Mr. Shafer is a sports enthusiast. However, active participation has shifted from baseball, basketball and football to what he refers to as "not particularly good golf."

Mr. Shafer manages a substantial business branch of the Foxboro Company in Pittsburgh and travels considerably on business matters. In addition to his activities in the above mentioned technical organizations he has more than a spectator interest in Community civic organizations.

Terminology conscious, Mr. Shafer says of his son's son, "which, according to our present terminology makes me a grandfather." Fortunately, terminology does not put age in a man's face or lag in his step.

It has been said that when one wants to get something done get a busy man to do it. That is "Al" Shafer and that he does things well is evidenced by his business success, and the assistance he has given to both the Instrument Society of America as a national organization, and the Pittsburgh Section of the Society.

WARREN F. HARING

Warren F. Haring, chairman of the 1947 Exhibitors' Advisory Committee, was graduated from Rensselaer Polytechnic Institute in 1934 with a degree in Electrical Engineering. At present he holds the position of Instrument Sales Manager for Wallace & Tiernan Products, Inc., Belleville, N. J.

Mr. Haring is a Member of the Washington Section of the Instrument Society of America, an Industrial Member of the Institute of Aeronautical Sciences, and a member of the American Society of Photogrammetry.

At the 1946 "Instrumentation for Tomorrow" Conference and Exhibit in Pittsburgh Mr. Haring was selected as chairman of the newly-organized Exhibitors' Advisory Committee. This committee, as its name implies, serves as an outlet for the views of the exhibitors and manufacturers of instruments in matters pertaining to the exhibit each year. The ideas and suggestions formulated by this committee to date have already had their effect in the preparations now going on for the 1947 Conference and Exhibit.

A short review of the committee's activities, written by Mr. Haring, will be found elsewhere in this issue.

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for the best member and guest attendance for the next three months.

At this meeting, Mr. George Agin, of the Sheffield Steel Corporation, presented a short basic lecture on "Dial Control Systems," after which the QUIZ KIDS answered questions concerning the various points under discussion.

The meeting was turned over to the main speaker of the evening, Mr. Harold R. Vaughn of the Westinghouse Electric Company. His talk was augmented by films and a most excellent response from the group.

On Tuesday, January 28, the speaker will be Capt. E. I. Hockaday of the Missouri State Highway Patrol, who will talk on "The Use of Scientific Instruments in Crime Detection and Solution." Captain Hockaday is a graduate of Westminster College (B.A. in chemistry) and a graduate of the F.B.I. National Academy of Washington, D. C. This program promises to be of great interest, since the devices used in this type of work cover the entire field of measurement—electrical, electronic, mechanical and chemical measuring instruments.

—OLIVER S. BOUTROS, *Sec'y-Treas.*

NEW JERSEY

November Meeting: The November 20th meeting of the New Jersey Section was a joint meeting at which we were guests of the New York Section. The meeting was held at the Men's Faculty Club at Columbia University. Mr. V. L. Parsegian of C. J. Tagliabue Division of Portable Products Company gave an interesting talk outlining the development of the new Tagliabue galvanometer for industrial instrumentation. Those attending enjoyed a fine dinner and the New Jersey group was well represented and took an active part in discussion after the talk.

December Meeting: This meeting was held on December 3, with the speaker of the evening being Mr. Wm. H. Fortney of the Humble Oil and Refining Company. His subject was "Instrument Shop Facility Requirements of a Modern Process Industry."

Mr. Fortney gave an outline of the personnel of his organization and explained the duties and responsibilities of each member by position. He gave an outline of his shop and traced the movement of the material being serviced. This was very clearly presented and demonstrated by many slides and pictures showing the various pieces of equipment for handling this type of work, with explanations of their use and operation.

Mr. Fortney stressed the point that because instrument shops are considered a maintenance department and are not in themselves producing a profit for management they are looked upon as a necessary evil and an unproductive cost. He showed how this situation could be improved by proving to management that production is increased and quality of product improved to such a degree as to offset the cost of maintenance of an adequate instrument shop.

The talk was very interesting and enjoyed by a large turnout. Many additional guests were on hand due to the Instrument Forum of the Standard Oil Company of New Jersey and the Power Show in New York. Among the guests was Dick Rimbach, who gave a brief outline of the activities of the National Society and told of the progress being made in organization of the 1947 Conference at Chicago, and the consideration of location for the 1948 Conference (which, he said, would probably be held in Washington, Philadelphia or New York). Since then it has been learned that at the meeting of the Board of Directors on December 4, Philadelphia was chosen by almost unanimous approval as the location for the 1948 Conference. We of the New Jersey group wish the Philadelphia Section every success and assure them of our full cooperation in making this first show on the Eastern seaboard a huge success.

January Meeting: The next meeting of the New Jersey Section will be held on Tuesday, January 7, at the Essex House in Newark. Speaker of the evening will be Mr. W. P. Wills of the Brown Instrument Company. His subject will be "Electric Pyrometry." We all look forward to an interesting evening.

February Meeting: For this meeting, we are going to try something new in the way

of subject material. The problem of education of instrument men will be approached from various angles. From the standpoint of college instruction on instrumentation, Professor Paul S. Creager of Rutgers University will present his views and take part in the discussion. Representing the instrument manufacturers will be Mr. M. J. Ladden of the Brown Instrument Division of Minneapolis-Honeywell Regulator Company, and representing the industrial training of instrument mechanics will be Mr. F. S. Rich of the Arthur G. McKee Company, who was head of instrument maintenance at the atomic bomb project at Oak Ridge. Mr. John J. Kelly of Calco Chemical Division of American Cyanamid Company at Bound Brook, New Jersey, will be responsible for the preparation of this program and will serve as chairman of the panel discussion.

We all look forward to a very lively and interesting discussion as we all know that there is room for improvement in the education of the young men who will be confronted with problems of instrumentation in the near future.

—GEORGE R. FEELEY, *Corr.*

NEW YORK

(Received too late for December issue)

The joint November meeting of the New Jersey and New York Sections was held at the Men's Faculty Club of Columbia University on Wednesday, November 20, 1946. A total of fifty members and guests from both groups enjoyed a delicious supper starting at 6:45 p. m. and about ten additional people came later for the lecture.

A short business meeting opened at 8:00 o'clock with a welcome to the New Jersey members from President Kayan of the New York Section. Professor Kayan then announced the appointment of a nominating committee as required by the local by-laws. He also announced the meeting of the Board of Directors to be held in New York on December 4th.

Mr. V. L. Parsegian, director of research for C. J. Tagliabue Division of Portable Products Corporation, was introduced at 8:15 as the speaker for the evening. The topic, "A New Galvanometer for Industrial Instrumentation," was presented in a very interesting manner. A brief history of the development of galvanometers was followed by an explanation of the mathematical laws of galvanometer behavior relative to damping, sensitivity and period. The design of a galvanometer for specific applications, particularly as to ruggedness and yet fitting certain specifications as to sensitivity and period, was then described. The completed instrument was exhibited and its construction explained.

A lively discussion period followed with the meeting closing at 10:15 p. m.

—CHARLES D. COREY, *Sec'y.*

OAK RIDGE

The regular December meeting of the Oak Ridge Section was held at Grove Hall at 7:00 p. m. on Tuesday, December 3. Mr. P. R. Bell of the Monsanto Chemical Company gave a very interesting lecture on "Wide Band Amplifiers and Counting Circuits." Mr. Bell helped design and build the cyclotron at the University of Chicago and worked in the research department at Radiation Laboratories at M.I.T. for five years. Currently Mr. Bell is working as a physicist on atomic energy pile design at Clinton Laboratories in Oak Ridge. The aspect of the talk gave evidence that the speaker is an electronic expert on pulse counting amplifiers.

The problems arising from the location of physical equipment used in construction of these amplifiers was brought out. A distinction was drawn between "fast amplifiers" and "wide band amplifiers" as used in amplifying pulse counts. Mr. Bell spent the remainder of the time discussing the effects and results of varying the size and physical location of tubes, conductors, etc. An involved but interesting discussion followed the lecture.

Preceding Mr. Bell's talk a discussion of the meeting place and dinner arrangements resulted in the appointment of a committee to investigate the matter. President A. V. Novak announced that plans were being made to have a shelf reserved at the Oak Ridge Library for technical books related to instrumentation.

The program committee announced that the January 8th meeting will feature Mr. Ronald Reamer of Taylor Instrument Companies as guest speaker. His subject will be "Time-Cycle Controllers and Co-ordinated Instrumentation."

The February 4th meeting will feature Mr. J. J. Grebe, Physical Research Director of Dow Chemical Company. Mr. Grebe is currently doing research work at the Training School of Clinton Laboratories at Oak Ridge. His subject will be "Unusual Control Problems."

—CHAS. W. COVEY, *Corr.*

I.S.A. IS ONE YEAR OLD

(An open letter to all members)

By RICHARD RIMBACH, *Secretary*

Dear Member:

The Instrument Society of America has just celebrated its first birthday! On January 10, 1946, the tenth local instrument society ratified the Constitution and thereby made the formation of the I.S.A. official.

We have grown by leaps and bounds to the point where we now have twenty-three Sections.

Will you help celebrate our first anniversary and at the same time "spread the gospel" of the I.S.A. by handing a membership application blank to someone you know who should be a member? By increasing the membership you will increase the potential service which the I.S.A. can perform for all its members.

Make it a Happy Birthday for the I.S.A. by interesting at least one new person in becoming a member.

A list of members will be published in the I.S.A. Transactions which will appear in the spring. For each new member who joins through your efforts, a star will be placed behind your name. Therefore, be sure to indicate on all membership application blanks that the membership was solicited by you.

Yours for a Prosperous New Year.

(signed) Dick Rimbach
Executive Secretary

ONTARIO

(Received too late for the December issue)

On Thursday, November 21, the Ontario Section met at the Haddon Hall Tea Room, Toronto, for dinner at 6:30 p. m. and a talk by Mr. M. J. Boho, Assistant General Sales Manager of the Hagan Corporation, Pittsburgh, Pa. Mr. Boho, whose activities for some time have been in connection with the general problem of Boiler Plant and Metallurgical Furnace instrumentation and control, presented a very interesting talk on "Boiler Combustion Controls."

In addition, a sound motion picture on television, entitled "Magic in the Air," was presented by courtesy of General Motors Corporation of Canada, Ltd.

—A. J. LEGAULT, SEC'Y.

PHILADELPHIA

The Philadelphia Section held its November 20th meeting at the Broadwood Hotel, with approximately 45 members attending the pre-meeting dinner.

Election of officers was held prior to the meeting by mail ballot. The following men were selected to head up this section for the next year: President, George N. Ehly; Vice-president, Edwin Kremer; Treasurer, John C. Whiddett; Secretary, Clarence Wood.

The election of President Ehly was the result of a run-off election of a 50-50 tie vote on the first ballot.

Dick Rimbach, National Secretary, attended this meeting and discussed briefly the plans for the 1948 Conference.

The main discussion of the evening was by four speakers instead of the usual one speaker. Four local instrument men discussed interesting problems in instrumentation.

The first speaker was Lyman Allen, from the American Viscose Company. He discussed a very unusual and interesting application for the displacement type level controller. The level controller gave the direct results of maintaining level in a chamber of pre-determined volume, thus permitting a measurement of weight with varying gravities due to temperature changes.

The second speaker was Robert L. Hurley of the duPont Company. Before his talk he asked three men from the audience to sit in the front of the room and attempt to solve a problem he had been given and had solved. When first sketched on the blackboard, the problem appeared simple. However, each time one of the selected men answered, Mr. Hurley would inject another angle which made the answer incomplete or incorrect. The entire build-up was humorous as well as interesting.

The third speaker was Mr. William A. Lindsay of the Atlantic Refining Company. Mr. Lindsay discussed the problem of a cycling air compressor delivering air to four oxidizing units. The compressor would run fully loaded until the receiver pressure built up to 13.8 psi at which time pressure switches would cause air to open the unloader valves at the inlet to the compressor. When the receiver pressure dropped to 11.8 psi the pressure switch would cause the unloader valves to close and the cycle would repeat itself. The compressor cycle time for this operation was 7 seconds loaded, 2.5 seconds unloaded. This type of operation threw a strain on the gears and motor so it was decided to attempt a method of smoothing out the operation in order to prevent further overheating of the motor.

The logical way of correcting this condition was to partially unload the compressor so it could be adjusted to the required load. A parabolic plug from a control valve was modified to fit into one of the inlet valves in the head end of the compressor and another to fit into one of the inlet valves in the crank end, to balance the work done by the compressor.

The final speaker was Ted Newcomb of the Gulf Oil Company. He discussed a very ingenious method for repairing squirrel cage blowers and for desooting home furnaces. While the topic was not exactly one pertaining to instrumentation, it resulted in a good laugh for everyone and added the necessary touch of spice to complete a perfect evening.

At the 42nd meeting, held on Tuesday, December 17, Mr. Otto B. Vetter, Ring Balance Company, Chicago, discussed "Measurement of Flow under Laminar and Turbulent Conditions at Elevated Pressures." Mr. Vetter's talk was not a highly technical one, but rather a review of the chief factors involved in the measurement of gas at high pressures with some consideration of the problems presented by the terrific pressures to which modern process design is leading.

On Wednesday, January 18th, the speaker will be Mr. Victor F. Hanson, Supervisor Applied Physics Section, duPont Experimental Station. His subject will be "Functions of an Instrument Development Laboratory."

Due to circumstances beyond our control, we are obliged to change the place and date of each forthcoming regular meeting. The January meeting place will be announced later.

—J. H. BERTRAM, Corr.

PITTSBURGH

January 27th meeting: "Pressure Gages," by Mr. A. E. Levan, United States Gauge Division, American Machine and Metals, Inc., Sellersville, Pa.

February 24th meeting: "The Endless Quest—the Application of Electrical Recording Instruments to the Solution of Problems of Industry and Technology," by

R. J. Kryter, Esterline-Angus Co., Inc., Indianapolis, Ind. —LESTER F. BOSS, Corr.

ST. LOUIS

The St. Louis Section held its regular meeting on November 25, 1946, at the York Hotel in St. Louis. The technical address was on the subject of "Metering of Difficult Fluids by the Force Balance Method." and was presented by Mr. J. B. McMahon of Republic Flowmeter Company, Chicago.

The speaker outlined the early uses of the force balance principle, which was first used in an industrial instrument by the Johnson Service Company in 1882, the instrument being a pneumatic force-balance thermostat. Mr. McMahon pointed out that the force-balance method is intrinsically more accurate than is the spring-balance method; for this reason an accuracy guarantee can be made to the effect that the output pressure of the instrument will follow the input impulse within ½ of 1% of absolute accuracy. The ratio of the input and output pressures depends only on the ratio of the diaphragm or bellows areas and their respective lever arms about the pivot point of the balance arm. The total movement at the measuring diaphragm is about 0.010 in., while at the flapper the total movement is about 0.002 in. This small movement means that the effective areas of the diaphragms will not change, and accuracy is maintained over the entire range of movement.

The absence of mercury avoids the trouble associated with this fluid in metering materials which attack mercury. The parts of the transmitter in contact with the fluid being metered can be constructed of resistant materials, and in many cases no sealing fluid is necessary to protect the meter. Internal meter parts can be made of phosphor bronze, silver, stainless steels, monel, or can be plated with gold or other metals. The meter has been used to meter all types of acids, dry chlorine vapors, Bunker C fuel oil, and many other difficult fluids.

Corrosion difficulties are minimized because of the small flow into and out of the diaphragm chambers due to the very small displacement of the diaphragm; hence, there is no tendency for protective films to be washed away. New plastic materials are being used very successfully for diaphragms. Materials such as Polyethylene and Teflon (Poly-tetrafluoro-ethylene) are resistant to practically all fluids, Teflon in particular being unaffected by anything except metallic sodium.

The mechanism is well adapted to suppressed scale arrangements. Weights on the weigh beam can be used for this purpose, as well as spring arrangements, with no sacrifice of accuracy. Suppressions up to eighty percent of full scale can be obtained. The forces developed in the transmitter are very high compared to those developed in conventional instruments, being measured in pound-inches. Consequently, parts must be made quite heavy, and are not easily damaged in service. The instruments can absorb large over-range operation without damage; without special protection, 3 times normal range is permissible, while with protectors, this may be increased to 6 times or even higher in some cases.

In cases where fluids in the lead lines must be kept hot to flow properly, the transmitter may be mounted directly on the flow line, and lagged to keep the leads hot. The small displacement of the measuring diaphragm minimizes any accumulation of material in the diaphragm chambers—in some cases a piston may be substituted for the diaphragm to give proper characteristics with some fluids.

The force-balance transmitter has also been applied to pressure measurement, liquid level, density and differential vapor pressure. All these applications can be used as the basis of a control system, in addition to their indicating and recording functions. The indicators and recorders (receivers) used are intrinsically pressure gauges and can be constructed in a variety of forms.

The speaker's presentation was extremely interesting, with the use of excellent slides. Mr. McMahon, Application Engineer for Republic Flowmeters, brought to the subject a wide knowledge of metering practice and experience, as well as a charm of manner and presentation which made this program one of the high spots in the presentations of the St. Louis Section. In our opinion, this development in metering practice deserves the widest publicity possible as a solution to many difficult problems.

Prior to the address, Mr. O. G. Forcade announced that the St. Louis Section will sponsor a Technical Paper Contest for the dual purpose of obtaining material for the Journal of the I. S. A. and stimulating progress in instrumentation and activity in the Section. (Ed. note—see also editorial in this issue.)

—H. E. ZEFFREN, Corr.

SOUTHERN MICHIGAN

Chicken Charlie's Restaurant, Kalamazoo, was the scene of the December 11th meeting of the Southern Michigan Section. Forty members and guests enjoyed an excellent steak dinner with all the trimmings.

During a short business meeting which followed, Dale Goodsell, of Consumers Power Company, reported that the Section now has 27 Members, 5 Associate Members and 2 Student Members, for a total of 34. Plans were made to put on a membership drive, and each member was asked to contact as many potential members as possible and try to interest them in the I.S.A.

Oliver Woods of the Upjohn Company gave a tentative outline of the programs for the next six months, the theme of which will be "The Instruments of Research," covering such topics as Neucleonics, Supersonics, Heat, and Instrumentation of Flight. The exact order, and the time and speaker for each meeting will be announced later.

Mr. Woods then introduced Mr. Norman Drake, Electronics Engineer of the Physics Department, Research Division, The Upjohn Company, who presented a very enlightening discussion on the "Electron Microscope." The differences between, and similarities of the Electron and the Optical Microscopes were explained.

Slides were used to illustrate the talk. Several were reproductions of actual pictures taken with the Electron Microscope now in use at the Upjohn Company. The very difficult and complicated method of preparing such objects as diphtheria germs, etc., on a collodion screen so that pictures might be taken, was fully explained.

The discussion was followed by a lively question and answer period. Everyone left the meeting with a deeper appreciation of the part to be played by the Electron Microscope in helping to make this a better and healthier world in which to live.

—KEN MEAD, Corr.

TENNESSEE

December meeting: Wednesday, December 11, Foreman's Room, Building 89, Tennessee Eastman Corporation, Subject: "Liquid Level Controls and Control Valves" by Mr. Ralph Rockwell, Director of Engineering, Mason-Neilan Regulator Company.

—FRANK H. THEILE, JR., Sec'y

WAYNE COUNTY

The Wayne County Section held its regular meeting on November 25th. A dinner at 6:30 p. m. was attended by 30 members. Following dinner a talk on "Electronic Potentiometers" was presented by Mr. W. A. Gneiser of the Leeds & Northrup Company.

The monthly door prize, donated by our First Vice-President, George Huff, was won by G. E. Flower at this meeting.

On December 16th, the Wayne County Section held its annual Christmas party for members and their wives and guests. After the dinner, several movies were shown, at the conclusion of which a drawing was held for several door prizes donated by the local instrument manufacturers' representatives and chemical plants.

The last item on the program was a quiz session conducted for the entertainment of the audience. Everyone had a chance to participate and no one went home empty-handed. About 50 members and guests attended.

The January meeting will be held on Monday, January 20, 1947, in Wyandotte, and the subject will be "Pressure Gauges and Pressure Recorders." (Our meeting night has been changed from the fourth Monday to the third Monday of each month.) We are planning a trip through a local steel mill as one of our forthcoming presentations.

—W. G. BAKER, Corr.

ISA EMPLOYMENT SERVICE

In printing these announcements the Society assumes no obligation as to responsibility of employers. Those replying to announcements should include two copies of their reply. When testimonial documents are to be included, copies of such documents and *not* the originals should be sent. The Society regards acknowledgment by employers of all applications as an act of courtesy but can assume no responsibility for their failure to do so. Address all replies to Employment Registration Committee, Instrument Society of America, 1117 Wolfendale St., Pittsburgh 12, Pa.

—C. F. GOLDCAMP, *Chmn. Employ. Reg. Com.*

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PHYSICIST OR ENGINEER (mechanical) to head up long-range fundamental project in connection with guided missile program. Background of research and development on instrumentation or automatic control equipment required. The position requires the planning of programs and the supervision of engineering personnel. Permanent position with unlimited opportunity in expanding engineering organization. Salary $6000 to $7000. Box 21.

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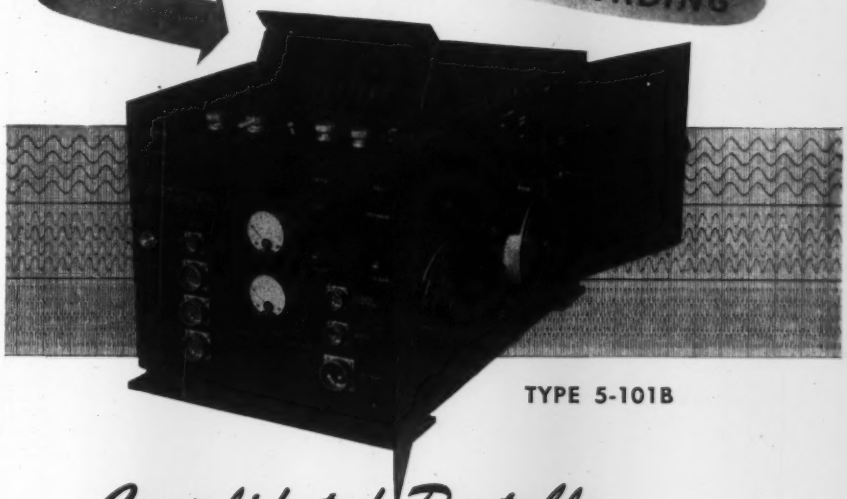

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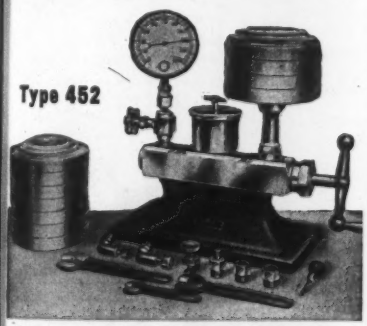

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Technical Society News

AKRON

Vice-President Wepsic officiated at the Akron Instrument Society meeting at the Guggenheim Institute on December 17th, Mr. C. B. Luther (Ye Prez) arriving late and tired from a long trip. In reporting on the progress of the contest for an appropriate emblem for the Society, Mr. Wepsic stated that only three entries had been received and that the contest would be continued. All members are invited to wrack their brains for a good design, the prize being one year's free dues.

Looking forward to our annual election in February, Messrs. C. B. Luther, D. M. Yoder, Howard Levine, H. C. Kinsinger and A. H. Richard were appointed to serve on the Nominating Committee.

Mr. Wepsic then introduced Dr. E. D. Haller, of the National Technical Laboratories, whose topic was "pH Measurement and Control." Dr. Haller described the various electrodes in common use and the precautions to be taken to obtain accurate measurements, particularly in cases of high temperature, high viscosity and high pH. He explained the use of buffers and the precautions to be observed in their use. He illustrated and described a number of installations in various services, also a number of pH tables used in industry. Dr. Haller's pertinent and timely talk on this important field of instrumentation was of great interest to the 50 members and guests present.

Dr. Huss, of the Guggenheim Institute staff, described the history and work of the Institute, which is now part of the College of Engineering of the University of Akron, being used as an Experimental Station. He told us of its important work in the fields of aerodynamics, meteorology, etc., particularly of its work in wind-gust measurements and in the instrumentation required in the various divisions, much of which is designed and constructed here.

The next meeting of the Society will be on January 28th, 7:30 pm, at the YWCA. The speaker will be Mr. C. B. Moore of the Moore Products Company. His subject will be "Pneumatic Null-balance Systems."

—FRED APPEL, JR., *Secretary.*

HARTFORD

W. I. Senger of the Gisholt Machine Co., Madison, Wis., will be the speaker at the January 15th meeting of the Hartford Society for Measurement and Control. His subject will be "Recent Developments in Balancing Machines."

The February meeting, on the 19th, will bring A. I. Peterson, Quality Control Manager of RCA at Harrison, N. J., who will speak on "Quality Control Applications." Both meetings will be held at the City Club in Hartford with dinner at 6:30 and the technical session starting at 8:00 P.M.

INDIANAPOLIS

The regular meeting of the Indianapolis Technical Instrument Society held December 3 was very well attended, there being about 65 members and guests present. Mr. Roy Thurman of the Indianapolis Power & Light Company gave a very interesting talk on the "Heat Pump" as used for domestic heating. One house in Indianapolis was heated last year by the heat pump and Mr. Thurman gave many of the figures and data for this experimental set-up. The well-insulated five-room house was heated at the cost of about 6300 kwh. of electric energy. A very lively discussion period followed the talk.

After the technical session the annual business meeting was held. The following officers were elected for the year 1947:

President: H. P. Rockwell, Jr., Rockwell Engineering Company.

Vice-President: L. G. Collet, Allison Division of General Motors.

Sec.-Treas.: M. R. Underwood, Indianapolis Power and Light Company.

Director-at-Large (2 Years): (1) N. W. Brinson, U. S. Naval Ordnance; (2) C. A. Gentry, Brown Instrument Company; (3) E. L. Keeler, Eli Lilly Company. Director-at-Large (1 Year): (1) W. H. Bollinger, Esterline Angus Company; (2) D. M. Mead, Diamond Chain Company; (3) S. F. Mulford, South Wind Division of Stewart Warner.

The society members present voted, more than three to one, to affiliate with the Instrument Society of America. This will be done as soon as arrangements can be made.

—MORRIS UNDERWOOD, *Sec.-Treas.*

LOUISVILLE

The Louisville Instrument Society held its first meeting December 10. This was an organizational meeting. Our two guest speakers were Mr. V. H. Heirmeyer, of the Brown Instrument Company, St. Louis, Mo., who gave a very interesting talk on why a community should have an active Instrument Society, and Mr. J. B. McMahon of the Republic Flow Meter Company, Chicago, and also Vice President of the I.S.A., who spoke on the advantages of a Local Section.

Officers pro tem were elected: Mr. E. H. C. Brown, President (Jos. E. Seagram & Son Company); Mr. M. J. Johnson, Treasurer (B. F. Goodrich Company), and S. W. Hawkinson, Secretary (Brown Instrument Company).

Ninety-one men attended this meeting and of this number 84 people joined the Society.

Our next meeting will be held on January 14, at 8:00 p.m., in Seagram's Auditorium in Louisville, and this meeting will be for the purpose of election of officers.

—S. W. HAWKINSON, *Secretary pro tem*

SOUTHERN CALIFORNIA METER ASSOCIATION

Our December meeting was held December 19th at the Rio Hondo Country Club, Downey, California. Mr. John M. Quirk of the Southern California Gas Company presented a paper and led a discussion on "The Ranarex Gas Gravitometer, Its Principles and Operation."

As a supplement there were shown for general interest the motion pictures of the Associated Oil Company of the 1945 Shrine East-West game held at San Francisco New Year's day.

At the November meeting held on November 21st there was a very good turnout of some 190 members to review the exhibits as displayed by the sustaining members of the Association. Late type instruments and equipment for the oil and gas industry were exhibited by the leading companies for what was a very successful sustaining members' night.

—CHARLES MERIAM

WHEN A FELLER NEEDS CONTROL BY Putt

WHAT'S THAT? YOUR #6 CONTROLLER IS OUT OF WHACK AND MUST BE SERVICED RIGHT AWAY — DARN IT MAN IT'S 4:45 AND WE HAVE GUESTS COMING FOR DINNER! WHY TH'#@!-*!! DIDN'T YA CALL AN HOUR AGO!
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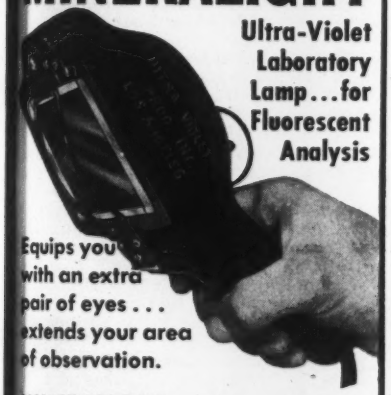

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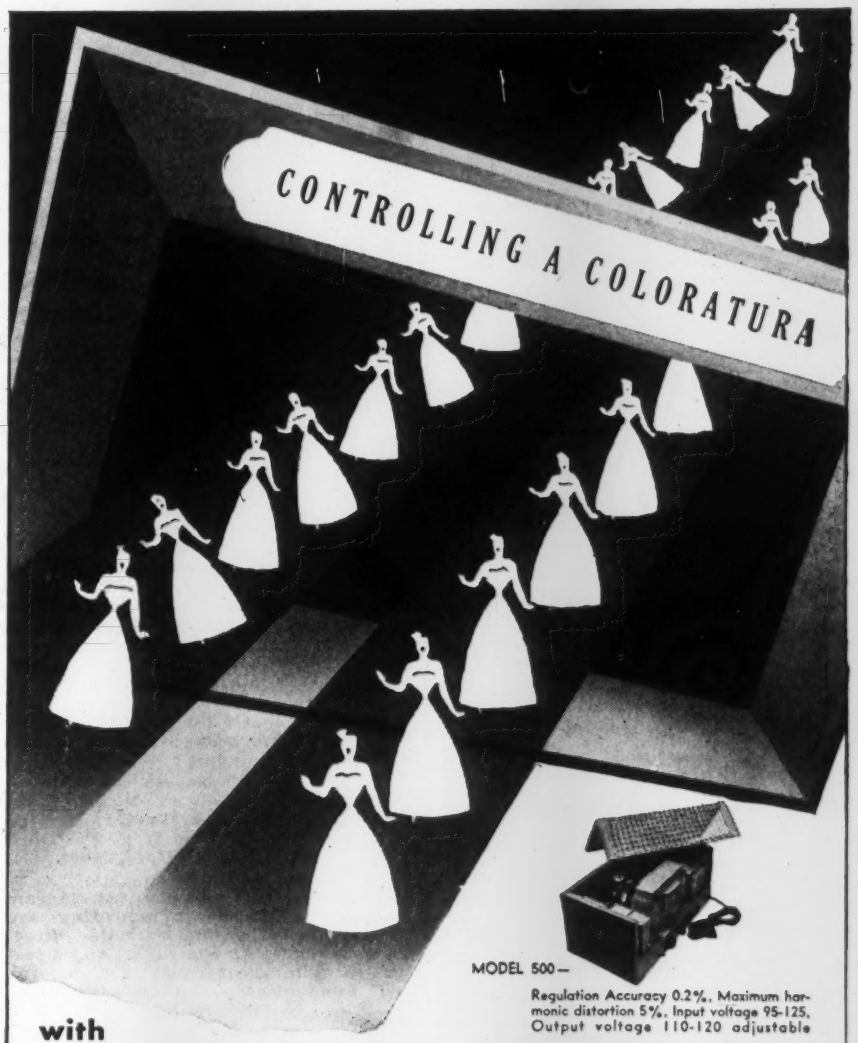

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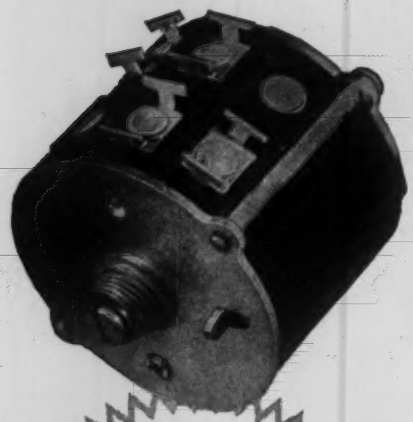

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Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on page 95.

O-1 **Galvanometers.** 12-page 8½" × 11" Bulletin No. 320 pictures and describes this maker's line of galvanometers including high-sensitivity, spot-light, pointer and "Pointerlite" types, and accessories. Rubicon Co., Ridge Ave., at 35th St., Philadelphia, Pa.

O-2 **Vacuum-tube Voltmeter.** 2-page 8½" × 11" Bulletin GEA-4574 pictures and describes the G-E vacuum-tube voltmeter with push-button switch for instantly selecting the voltage or decibel range desired. General Electric Co., Apparatus Dept. Schenectady, N. Y.

O-3 **Cathetometer.** 2-page 8½" × 11" folder pictures and describes the Eberbach Cathetometer for either vertical or horizontal use. Eberbach & Son Co., Ann Arbor, Mich.

O-4 **"Aerovox Research Worker."** 4-page 8½" × 11" Vol. 18, No. 7 of this house organ features "Part 5. Klystron and Magnetron," of the V. H. F. Primer. Aerovox Corp., New Bedford, Mass.

O-5 **Controllers.** 4-page 8½" × 11" bulletin describes and pictures diagrammatically a direct-set indicating controller, non-indicating controller, direct-set non-indicating controller, and direct-set recording controller for pressure and temperature. Gotham Instrument Co., Inc., 149 Wooster St., New York 12, N. Y.

O-6 **Tachometers.** 12-page 8½" × 11" Bulletin S1400 pictures and describes this maker's line of tachometers for recording and indicating speed of rotation and speed of travel. The Bristol Co., Waterbury 91, Conn.

O-7 **Variable Voltage Transformer.** 4-page 8½" × 11" Bulletin 20 pictures and describes the "Type 20 Powerstat" of ½ kva. capacity. Superior Electric Co., Bristol, Conn.

O-8 **Resistors, etc.** 4-page 8½" × 11" bulletin pictures and briefly describes this maker's line of attenuators, fixed pads, precision resistors, switches, measuring equipment, and a calculating bridge. The Daven Co., 191 Central Ave., Newark 4, N. J.

O-9 **Rheostats.** 8-page 8½" × 11" Catalog No. 3 pictures and describes the various sizes and types of rheostats available from this maker, and includes a discussion on rheostat construction. Rex Rheostat Co., Baldwin, L. I., N. Y.

O-9a **Thread Gages.** 4-page 8½" × 11" bulletin pictures and describes line of plug and ring thread gages in "go" and "no go" types. West and Dodge Thread Gauge Co., Inc., 6 Power House St., South Boston 27, Mass.

O-10 **Radioactivity Instrumentation.** 9-page 8½" × 11" bulletin pictures and describes this maker's line of instruments for radioactivity detection and measurement. Instrument Development Laboratories, 817 E. 55th St., Chicago 15, Ill.

O-11 **Calculating Machines.** 2-page 8½" × 11" bulletin pictures and describes four models of the "Original-Odhner" mechanical calculating machine for business or scientific calculations. Ivan Sorvall, 210 5th Ave., New York 10, N. Y.

O-12 **Dial-indicating Thermometers.** 4-page 8½" × 11" bulletin pictures and describes "Trerice" dial-indicating thermometers in vapor-actuated and mercury-actuated types. Also shown are accessories, panelboards, etc. H. O. Trerice Co., 1420 W. Lafayette Blvd., Detroit, Mich.

O-13 **Audio-frequency Oscillator.** 4-page 8½" × 11" bulletin pictures and describes the "Model 201B" a-f. oscillator and the "Model 330B" distortion analyzer. Includes technical data on 20 other electronic instruments. Hewlett-Packard Co., Box 1188, Station A, Palo Alto, Calif.

O-14 **Resistors, Transformers, etc.** 16-page 8½" × 11" booklet pictures and describes this maker's line of wire-wound resistors, transformers, chokes, trimmer condensers, loop antennae and electronic equipment. Madison Electric Products Corp., Madison, N. J.

O-15 **Temperature Controllers, etc.** 8-page 8½" × 11" Bulletin 340 pictures and describes this maker's line of temperature controllers, "Saf-T-Flame" gas pilots, dial thermometers, limit controls, recorders and timers. The Partlow Corp., New Hartford, N. Y.

O-16 **Servomechanism.** 1-page 8½" × 11" Bulletin H-26 pictures and describes the "Motron" electronic servomechanism for automatic control applications. W. C. Robinette Co., 802 Fair Oaks Ave., South Pasadena, Calif.

O-17 **Z-angle Meter.** 4-page 6" × 9" bulletin pictures and describes the "Type 310-A Z-angle Meter" for impedance measurement. Technology Instrument Corp., 1058 Main St., Waltham, Mass.

O-18 **Radioactivity Measuring Instrument.** 8-page 8½" × 11" bulletin pictures and describes the "Autoscaler" radioactivity measuring instrument. Tracerlab, Inc., 55 Oliver St., Boston, Mass.

O-19 **Instrument Motor.** 4-page 8½" × 11" Bulletin 10 pictures and describes the Cramer "Type SX" self-starting synchronous timing motor for instrument applications. The R. W. Cramer Co., Inc., Centerbrook, Conn.

O-20 **Constant-temperature Baths.** 6-page 8½" × 11" folder pictures and describes maker's line of constant-temperature baths in various types. E. H. Sargent & Co., 155-165 E. Superior St., Chicago, Ill.

O-21 **Phase Sequence Indicator.** 2-page 8½" × 11" bulletin pictures and describes this maker's phase sequence indicator for numerous applications. Measurements Corp., 116 Monroe St., Boonton, N. J.

O-22 **Industrial Thermal Analyzer.** 12-page 8½" × 11" Catalog D-1 pictures and describes the Chevenard industrial thermal analyzer and differential dilatometer. R. Y. Ferner Co., Investment Bldg., Washington, D. C.

O-23 **Remote Control Servomotor.** 2-page 8½" × 11" bulletin pictures and describes the "Transicoil" 60-cycle 2-phase low-inertia servomotor for remote-control applications. Transicoil Corp., 114 Worth St., New York 13, N. Y.

O-24 **"Pocket-size" Oscilloscope.** 2-page 8½" × 11" Bulletin AHT001 pictures and

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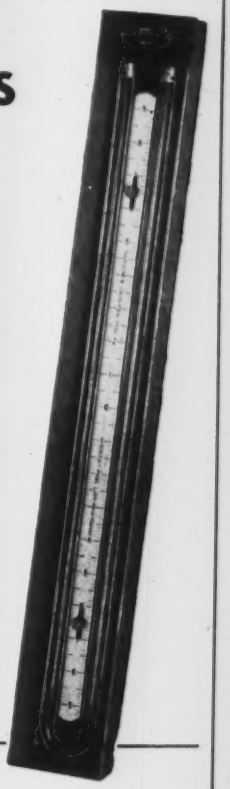

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escribes the "Model S-10-A Pocketscope," a miniature cathode-ray oscilloscope. Waterman Products Co., Philadelphia 25, Pa.

O-25 **Pressure Gages.** 8-page 8½" × 11" Catalog G-12 pictures and describes maker's complete line of indicating pressure gages, with structural features and dimensions. Gotham Instrument Co., Inc., 149 Wooster St., New York 12, N. Y.

O-26 **Selenium Rectifiers.** 8-page 8½" × 11" catalog pictures and describes maker's line of selenium rectifiers. Includes table of ratings, graphs of characteristics, and circuit diagrams illustrating applications. Radio Receptor Co., Inc., 251 W. 19th St., New York 11, N. Y.

O-27 **Graphic Recorders.** 20-page 8½" × 11" Catalog No. 1 pictures and describes "Model FR" automatic frequency response recorder and accessories, "Model PL" automatic high-speed power level recorder, "Model PL-E" high-speed energy level recorder, and other recording instruments. Sound Apparatus Co., 23 Broadway, New York 7, N. Y.

O-28 **"Aminco Laboratory News."** 12-page 8½" × 11" Vol. 3 No. 4 of this house organ contains a number of short articles of scientific interest. American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.

O-29 **Radiation Pyrometer for Open-Hearth Bath Measurements.** 16-page 6" × 9" Reprint N-33B is a reprint of an article by H. T. Clark and S. Feigenbaum from *Metals Technology*, June 1946. Leeds & Northrup Co., 4908 Stenton Ave., Philadelphia, Pa.

O-30 **"Sperryscope."** 24-page 9" × 12" Vol. 10 No. 11 of this house organ contains several articles on the activities of The Sperry Corporation and its subsidiaries. The Sperry Corporation, 30 Rockefeller Plaza, New York 20, N. Y.

O-31 **Photoelectric Controllers, etc.** 36-page 9" × 12" loose-leaf catalog pictures and describes photoelectric and electronic controllers, electronic pilot relays and timers, level controllers, smoke density indicators and recorders, and flame-failure safeguards. Photoswitch, Inc., Cambridge 42, Mass.

O-32 **"General Radio Experimenter."** 8-page 6" × 9" Vol. 21 Nos. 2 and 3 of this house organ is devoted to a description of the new "V-10 Series Variacs" of 10-amp. capacity. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

O-33 **Miniature Switch.** 2-page 8½" × 11" Data Sheet No. 39 pictures and describes the "V3-1 Microswitch" and auxiliary actuators. Microswitch Div. of First Industrial Corp., Freeport, Ill.

O-34 **Pressure Transmitters.** 2-page 8½" × 11" Catalog Sheet P-6 pictures and describes the "Model P6 Statham Pressure Transmitter" for remote indicating or recording of gas or liquid pressure. Statham Laboratories, 8222 Beverly Blvd., Los Angeles 36, Calif.

O-35 **High-altitude Test Chambers.** 2-page 8½" × 11" bulletin pictures and describes the "Bowser Altitude Units" in two models to meet vacuum conditions from 5000 to 75000 ft. of altitude. Bowser, Inc., Refrigeration Div., Terryville, Conn.

O-36 **Aircraft Receiver.** 6-page 8½" × 11" folder pictures and describes the "Model RA-1 Series Receiver" for aircraft, including direction-finding and azimuth control components. Bendix Radio, Div. of Bendix Aviation Corp., Baltimore 4, Md.

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